Understanding Emirati women's reasons to study the STEM-related subject of engineering: Lessons from Dubai

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by Caroline Louise Jenns

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Abstract

Since the United Arab Emirates was formed in 1971, the pace of change in this country has been considerable, moving from a largely rural society to a predominantly urban one in just under fifty years. As, globally, it has been recognized that STEM-related graduates are necessary to move towards knowledge-based economies, so too the government of the United Arab Emirates has sought to develop their country around this vision in recent years. Despite this ambitious vision, literature available at the time of this research suggested that Emirati culture had not kept pace with this change.

Globally, there is a shortage of women in STEM-related majors in Higher Education and subsequently in STEM-related careers. By contrast, in recent years, there has been a significant rise in the number of Emirati female students at one Higher Education institution in Dubai choosing to study the STEM-related subject of engineering. This initially appeared to be at odds with the culture and traditions of Emirati society as literature suggested engineering was considered to be a male-dominated career and Emirati females were discouraged from interacting with males outside their immediate family due to societal traditions.

The purpose of this research was to establish the reasons for the rise in Emirati females at this institution opting to study engineering and, in turn, to bridge the literature gap related to Emirati females' Higher Education study path decisions and, specifically, their rationale for choosing to study the STEM-related subject of engineering. This was carried out as a case study using an explanatory sequential MMR approach.

While there were undoubtedly a multiplicity of factors surrounding these students' decision to study engineering, two key influences emerged. Firstly, the continuing influence of Emirati families as part of a larger collectivist society and secondly, a shift in society towards the increasing acceptance of Emirati women's place in engineering, aligning with the government's vision for the future of the country. Beyond highlighting this societal shift, this study shows the importance of introducing STEM subjects early into the education system to encourage the uptake of STEM, while also providing a springboard for further research in this area.

Some key words that relate to this research study include Emirati females, Engineering, STEM, Higher Education, subject choice.

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Chapter 1: Introduction

1.0 Aim of the research study

The aim of this research study was to uncover the reasons for the recent significant rise in the number of Emirati females at a Higher Education (HE) institution in Dubai in the United Arab Emirates (UAE) opting to study the STEM-related subject of engineering, despite the fact that this field was still considered to be male-dominated and therefore in contrast to the documented social norms for these female students in this context.

1.1 What is STEM?

Since its creation in 2001 by the National Science Foundation, the acronym *STEM* has been universally accepted as standing for Science, Technology, Engineering and Mathematics (Breiner, Harkness, Johnson, & Koehler, 2012; Marrero, Gunning, & Germain-Williams, 2014; Sanders, 2009). However, the finer points of the subjects this acronym encompasses may be interpreted differently by different stakeholders both inside and outside educational institutions (Breiner et al, 2012). Indeed, since the acronym was established, STEM has been used interchangeably by some stakeholders to refer to only some of the fields it represents, such as science and mathematics (Breiner et al, 2012; Bybee, 2010). Equally, it has been suggested that there is a need to include the term *education* after this acronym to further differentiate between STEM in industry and STEM in education (Sanders, 2009).

Regardless of the varied conceptions and interchangeable terms used when referring to STEM in general, for the purposes of this research, STEM will refer to the subjects of Science, Technology, Engineering and Mathematics.

1.2 Background

Since the beginning of the 21st century, an increase in the ubiquity of communication and information technology along with an "increasingly integrated world economy" (Altbach, Reisberg, & Rumbley, 2009, p iv) has given rise to globalization. Among UNESCO's definitions of globalization, the one which aligns with this particular context defines it as "the intensification of worldwide social relations which link distant localities in such a way that local happenings are

shaped by events occurring many miles away and vice versa" (Giddens, 1990, cited in UNESCO, 2017).

As the development of knowledge economies and globalization are seen as related, with OECD countries viewing globalization as a "key driver and determinant of change" (Brinkley, 2006, p 9), many governments now recognize the need to develop and support their population to be able to adapt, compete, and thrive on this international stage and to support and sustain long-term economic development through the establishment of knowledge-based economies (Chen & Dahlman, 2005, p 1). It has also been suggested that for nations to succeed in a globalized world it is necessary for their workforce to be well-educated in general, but with an emphasis on moving towards HE graduates in engineering and scientific majors in order to support continued technological innovation (Chen & Dahlman, 2005). Indeed, increasing the number of graduates who are attuned to STEM majors is an essential part of the development of a knowledge-based economy.

This is particularly true in the Middle East where traditionally economies have been based on oil revenue, especially in the Gulf Cooperation Council (GCC) countries. As oil prices have dropped and the finite lifespan of this type of revenue has been recognized, these countries have begun to diversify their economies (Kumar & Van Welsum, 2013; Weber, 2011) and to initiate other ways to safeguard their countries' futures. In turn, some GCC governments have now placed a strong focus on the development of their economies as knowledge-based including Qatar (Ministry of Development and Planning Statistics, 2019), Saudi Arabia (Bashehab & Buddhapriya, 2013; Khorsheed, 2015) and the UAE (UAE Vision 2021, 2018a), which has led to the need to develop their populations as a human capital resource (Kumar & Van Welsum, 2013) to support these ambitious plans. As the drive towards competing in the global economy relies on all members of these countries' indigenous populations being involved, the need to graduate citizens in STEM-related subjects and to subsequently obtain employment in these fields upon graduation is crucial to the development of these government's visions of successful and sustainable knowledge economies.

Although it has been suggested that focusing on the development of human capital to support a knowledge-based economy has the potential to be at the expense of individuals, in the case of the UAE the vision set out by the government is designed to be inclusive in educating their indigenous population, while simultaneously keeping pace with global changes.

Perhaps unlike other HE institutions around the world where the rise of academic capitalism has had the potential to lead to "supply-side higher education" (Rhoades & Slaughter, 1997, p 9) with a tendency to take on the characteristics of profit-making institutions, the UAE's federally-funded HE institutions are explicitly not-for-profit and their aim is specifically to prepare the indigenous population to meet the needs of the UAE labour market and society. To ensure their success, these institutions are both well-funded and well-resourced to be able to carry out this mission. Consequently, they are in a position to strive to develop best educational practice in line with the government's vision to move towards a sustainable country in which the indigenous population are adequately equipped to contribute towards the development of the country. Furthermore, unlike other HE institutions around the world, where it may be increasingly necessary to rely on additional funding and student fees to boost existing public sector funding (Rhoades & Slaughter, 1997), as the UAE's federally-funded HE institutions are strongly supported by the government this allows them to focus on building the nation's human capital towards a knowledge-based economy and the changing needs of the nation, rather than on generating revenue streams to sustain themselves.

Although it may appear on the surface that these UAE HE institutions are consequently preparing future workers for industry rather than educating individuals (Rhoades & Slaughter, 1997), these institutions also emphasis the inclusion of soft skills as part of the educational journey of their students. In addition, all members of the indigenous population who meet the entry requirements of these HE institutions are eligible for enrollment, ensuring all elements of the population are included and given access to equal educational opportunities.

1.2.1 The UAE setting.

This research study is based in the emirate of Dubai, one of seven emirates which comprise the UAE. Although each emirate has its own influences and dynamics, in general the

norms and traditions of Emirati society are similar throughout the country. As the UAE emerged from a group of tribes, the current government comprises of the rulers of the original "tribal federations that dominate[d] each emirate" (Peck, 2001, p 150) ensuring that these ruling families represent the major tribes of the UAE (Abdulla, 2005). The UAE government therefore comprises of rulers from each of the seven emirates, with each of these rulers having a vote in state decisions as part of the Federal Supreme Council. This council is the highest political authority in the country holding both "executive and legislative powers" (Peck, 2001, p 150). Although the government is responsible for the general policy of the UAE, electing the UAE President and Vice President, ratifying "federal laws and international treaties" and preparing the federal budget (Peck, 2001, p 150), it is worth noting that the members of the government also govern each of their own emirates separately too, giving rise to some subtle differences in their own Executive Councils, by emirate. This is written into Article 117 of the UAE's constitution and includes the "raising of social and economic standards" (Government.ae, 2019a) within each of the emirates.

Perhaps unlike other countries, the UAE government is accessible to the indigenous populace through *majlises* which are open meetings regularly held at palaces throughout the country. These meetings provide the opportunity for Emiratis to maintain communication with their rulers despite the urbanization of the country (Peck, 2001). Possibly as a result of this open communication and the fact that the government has effectively assumed the role of provider of services such as education and welfare, which was previously the responsibility of the family unit, as documented by Abdulla (2005), the government has earned the immense respect and admiration of the majority of the UAE population. In general, this has also resulted in support and/or acceptance for government policies within the indigenous population.

1.2.1.1 The UAE populace.

As of mid-2017, the UAE population was estimated to be just over 9 million people (Federal Competitiveness and Statistics Authority, 2018a). At the time of this research study, published figures estimated the indigenous population of the UAE to comprise of only 947,997 Emirati nationals, with the remaining population made up of expatriates from over 200

different countries (Government.ae, 2019b). These expatriates are either working in the UAE on fixed renewable contracts or business owners on fixed-term economic visas. Expatriates are entitled to sponsor other family members to live in the UAE, but their eligibility to do this is based on their monthly salary. Emirati citizenship is granted through lineage to descendants born in or prior to 1925 in the lands now known as the UAE (Government.ae, 2019c). As a result, citizenship is rarely given due to naturalization.

Of the population who are employed, 91% of workers are expatriate (Parcero & Ryan, 2017), with the bulk of these expatriate workers being male. This huge discrepancy between the indigenous and expatriate workforce originated from the need for expatriate workers to support the development of all aspects of the UAE's infrastructure when it was first established. Although the founding UAE government understood the need to recruit best practices from around the world to initially build the country (Burden-Leahy, 2009), this has now led to the UAE's current socio-economic feature of having a swollen population from the substantial expatriates who still work towards developing and sustaining the UAE (Shihab, 2001). This disparity between the numbers of indigenous and expatriate workers has the potential to create a long-term issue as, although it is clear that the UAE can import human capital to support their future knowledge economy in the short-term (Kumar & Van Welsum, 2013), sustaining this type of economy in the long-term will require the utilization of all members of their indigenous workforce.

Looking at the current statistics of the Emirati workforce, although there are more female than male Emirati HE graduates, of the current Emirati workforce only 32.4% are female (Federal Competitiveness and Statistics Authority, 2018b). This potentially means that half of the employable indigenous population are not contributing to the labour market in general, and STEM industries in particular. Therefore, developing Emirati human capital will not only require continued HE in general, with a strong emphasis on STEM subjects including engineering, it will also need a focus on employing more Emirati female graduates from STEM subjects to support the development of the UAE's knowledge economy overall.

1.2.1.2 The UAE workforce.

This situation of having a relatively small indigenous workforce to draw on is one that is unlikely to change as the threshold whereby Emiratis could constitute the majority of the workforce has now already been reached, according to a World Bank report (Ruppert, 1999, cited in Burden-Leahy, 2009). Although the UAE government still plans to recruit world-class talent from overseas to support their plans for a knowledge-based economy, they have also recognized the need to harness the talents of their own Emirati population in this regard (UAE Vision 2021, 2018a). Indeed, an Emiratisation programme specifically dedicated to improve the number of Emiratis currently employed in the workforce (UAE Ministry of Human Resources & Emiratisation, 2018a) is one of the initiatives which has been established to support this. This programme also extends to recognizing the role that Emirati females can play in the development of a knowledge economy, with the UAE government stressing the importance of women being given equal opportunities and of the contribution they can make towards the economy in general (Gallant & Pounder, 2008; Marmenout & Lirio, 2014).

1.2.1.3 Current political situation in the region.

It is also worth noting that, just as globalization has influenced the UAE, another recent impact on UAE nationals has been the geo-politics of the region including the ongoing war in Yemen and the rift with Qatar (Ibish, 2017). These events have contributed to a recently-instigated military service (National and Back-up Service Commission, 2015), which is also likely to have contributed to Emirati students' increased sense of patriotism and a desire to contribute towards their country's development ("National service", 2017). Although this mandatory military service is for all medically-fit Emirati males aged between 18 to 30 years old, it is likely to have had an impact on Emirati society in general as this military service has also resulted in a necessity for Emirati females to take up the workforce roles which these males would previously have held. Indeed, as Emirati women take on these roles in addition to overtaking the number of male HE graduates, the potential this social impact could have on the country in the long term is something that the UAE may need to consider (Findlow, 2013).

1.3 Researcher's background

Overall, I have been working alongside Emiratis in the UAE for just over twenty years. As a European citizen I am not part of the indigenous culture, but instead I am viewed as a Western expatriate and therefore an outsider in terms of Emirati society. However, my time in this country has given me the opportunity to develop relationships with Emiratis and to develop a greater understanding of Emirati society and culture in general. I believe this places me in a strong position to be able to draw conclusions from the data uncovered in this research study, while at the same time reducing the possibility of providing a distorted account of UAE society as a Western expatriate.

At the outset of this research, my role within the institution where this research study took place was Programme Coordinator of a bridging programme. This programme was designed to support students in gaining the academic requirements needed for entry to all Bachelor of Applied Sciences (BAS) programmes at this institution and to facilitate programme choice advice sessions to support students in making their most appropriate choice of BAS. As a result, I also had a particular interest in this research in this role as, while this research did not directly impact my programme, it could have played a role in providing further insight into our students' choice of BAS, thereby contributing towards an improved career counselling service for future students in this bridging programme.

Acknowledging my position as an insider researcher (Becher & Trowler, 2001) with a leadership position at this institution, it was therefore important to choose students who were no longer in this bridging programme to reduce any perceived conflict as a researcher and member of the management team. This also reduced any potential power balance issues with students in this research study, which could have occurred if they were students who were in the bridging programme and had yet to make their choice of BAS.

However, since embarking on this research study, it was announced that the bridging programme will no longer exist in its current form, but instead English language studies will be subsumed into the General Studies department at this institution from August 2019, with students being accepted directly into their BAS programmes. Nevertheless, the English

language requirements for BAS programmes remain the same and students still need support to meet these language levels. This does not affect the findings of this research as the students who took part in this study were already in their BAS programme of engineering. My own role has changed to become Program Coordinator of the English Communication Courses as part of the General Studies department.

One of my sub-research questions focused on how data from this research study could inform program choice counselling for future students of the bridging programme at this institution. All data collected related to this question will now inform program choice counselling for students in General Studies in their first year rather than students in the bridging programme, prior to formally engaging with their BAS programme. It could even inform the programme information shared with students during the institution's orientation programme, which is delivered over one day in the week prior to students joining. Although this orientation programme is designed to share information and study pathways related to the programmes which students have already chosen to study, it may also show that this information has the potential to influence these students' ultimate programme decisions.

1.3.1 Researcher's assumptions.

When I initially started this research study I had the assumption that the students at this institution made their HE choices themselves. I believed that although they may have been influenced by the world around them, including their friends and family, their chosen study path was one which aligned with their strengths and abilities, both academically and personally. I also assumed that some students may have chosen their HE major with a view to their long-term career path and that this may have been influenced by other Emirati females who could have advised them on their careers. However, after conducting this empirical research I found that the answers to my questions were far more complex than I had initially considered. This will be explored further in Chapter 5.

1.4 Research setting

1.4.1 Cultural setting.

Despite the UAE government's vision to move towards a knowledge-based economy as part of the influence of globalization, it would appear from the literature available at the time of this research study that UAE society is still largely traditional. Indeed, although globalization has had some effect on the predominantly patriarchal nature of Emirati culture (Abdulla, 2005; Khelifa, 2010), current literature suggests that it still remains prevalent throughout Emirati society, possibly due to the country's Islamic and tribal traditions (Alzeer, 2018; Burden-Leahy, 2009). This will be discussed further in Chapter 2.

1.4.1.1 Collectivism and UAE society.

UAE society is also considered to have a strong collectivist element (Hofstede Insights, 2018), with individuals eschewing their own personal interests in favour of the larger familial and societal interests. This idea of *collectivism* originates from research carried out in over 60 countries, in which four national culture dimensions were identified including *individualism versus collectivism* (Hofstede Insights, 2019b). Societies or countries that exhibit strong collectivist traits tend to have citizens who identify as being part of a larger group or "we" rather than "I" (Hofstede Insights, 2019b).

Indeed, it is generally accepted that Emiratis acquire their cultural identity and status within Emirati society through their family, with family interests overriding all individual interests (Abdulla, 2005). This leads to the belief that each member of an Emirati family represents the family overall, with choices, decisions and actions made by individual family members considered to reflect on the family as a whole (Abdulla, 2005). This is particularly true of females within Emirati families, as any actions they commit which could be considered inappropriate are likely to cast their immediate family in an unfavourable light within the Emirati community (Barakat, 1993). Equally, positive actions and appropriate achievements cast a favourable light on their family as a whole.

1.4.1.2 Emirati women in the UAE.

While Emirati females are strongly encouraged by both the government and their families to enroll in HE (Alzeer, 2018; Burden-Leahy, 2009) to the extent that they now outnumber males, as mentioned earlier, the evidence suggests there can still be familial restrictions on where they are permitted to work. Certainly, literature available at the time of this research study suggests that the influence of family is a major factor in Emirati females' study and career decisions.

In their qualitative study of Emirati women who were either business owners or employed at a managerial level, Kemp and Zhao (2016) found that familial influence had still been a significant influence on their career path. Similarly, in Al Darmaki's (2012) study exploring the attitudes of Emirati students towards career counselling, she concluded that Emirati women were receptive to the idea of career counselling as they had not previously been exposed to this concept nor trained to make study or career path decisions themselves as their families largely made these life decisions for them.

The fact that Emirati females' relatives still significantly influence their study and career pathway decisions (Al-Darmaki, 2012; Aswad, Vidican, & Samulewicz, 2011; Kemp & Zhao, 2016; Khelifa, 2010; Wagie & Fox, 2005) is noteworthy in this context as engineering can often be viewed as a male-dominated subject by society, with UAE society being no exception (Al-Darmaki, 2012; Kemp & Zhao, 2016), and Emirati families have traditionally steered their female relatives away from male-dominated career pathways (Abdulla, 2005; Al-Darmaki, 2012; Kemp & Zhao, 2016). Clearly, graduating with a STEM or Engineering BAS is less likely to provide employment in a gender-segregated workplace for Emirati females.

Indeed, despite the significant increase in the number of females in the workforce (Bennett & Wright, 2010), as Emirati culture is still largely influenced by Islamic and tribal traditions most females have been encouraged to work in gender-segregated workplaces (Abdulla, 2006). Until recently there were also few female students in the UAE opting to study the STEM-related subject of engineering, despite the fact that 95% of Emirati females were enrolled in HE compared to less than 50% of Emirati males (UAE Ministry of Education, 2005,

cited in Wagie & Fox, 2005; UAE MoHESR, 2003, cited in Wagie & Fox, 2005). In fact, in the academic year 2010-11, only 16% of graduates from the STEM-related major of engineering were female, as the majority chose to study Business majors instead, resulting in 60% of all business graduates being female (Kemp, 2013).

This lack of Emirati female STEM graduates is not unique as, globally, it has been well-documented that there is a shortage of females studying STEM-related subjects in HE (Archer, DeWitt, Osborne, Dillon, Willis & Wong, 2013; Hill, Corbett, & St Rose, 2010; Marginson, Tytler, Freeman, & Roberts, 2013; Smith, 2001). It has also been widely recognized that more females should be encouraged to study STEM-related subjects to rectify a gap in the number of females in STEM-related careers leading to a potential lack of female input in this area (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011; Hill et al, 2010). However, despite the well-documented shortage of STEM graduates in the West and of the need to address this situation, this continues to be an issue. This will be discussed in more detail in Chapter 2.

An apparent juxtaposition has been created, therefore, with Emirati families documented as discouraging Emirati females from studying in male-dominated fields and engaging with these professions as part of traditional Emirati culture, while the UAE government aims to rectify the situation of increasing the number of Emirati STEM graduates, including females, to contribute towards their vision of a knowledge-based economy.

In addition to the necessity for more Emirati females to graduate in STEM-related subjects such as engineering to contribute to this economy, based on the discrepancy between the number of female and male graduates in general, increasing the number of Emirati women in engineering in the UAE is also important for society in general. As the family unit continues to have such a strong focus and importance in UAE society (Abdulla, 2005) and as women tend to be the focal point of this unit, graduating women in STEM-related subjects is likely to elevate these subjects within their families.

Graduating with an engineering qualification is also likely to raise Emirati women's profiles in both their own emirate and the UAE due to the prestige associated with this qualification. This in turn could ensure that more of their voices are heard and their input is

considered in the development of the UAE, eliminating potential issues which have occurred in other countries as a result of a lack of women in STEM (Hill et al, 2010), as mentioned earlier. It also has the potential to provide optimized job and financial security as the BAS major currently documented as most in demand in the UAE is engineering (Appendix G).

1.4.2 Institutional setting.

Despite literature suggesting that there is a shortage of Emirati females choosing to study and work in the field of engineering (Aswad et al, 2011; Mahani & Molki, 2011), recently there has been a significant increase in the number of Emirati females at a HE institution in the UAE opting to study the STEM-related subject of engineering. This number has grown from only 1.22% of the total student population at this institution in 2014 to 20% of the student population in 2018 (Figure 1). This rise in engineering students, since it was introduced in 2014, contrasts with an overall drop in student enrollment in general at this institution (Figure 1).

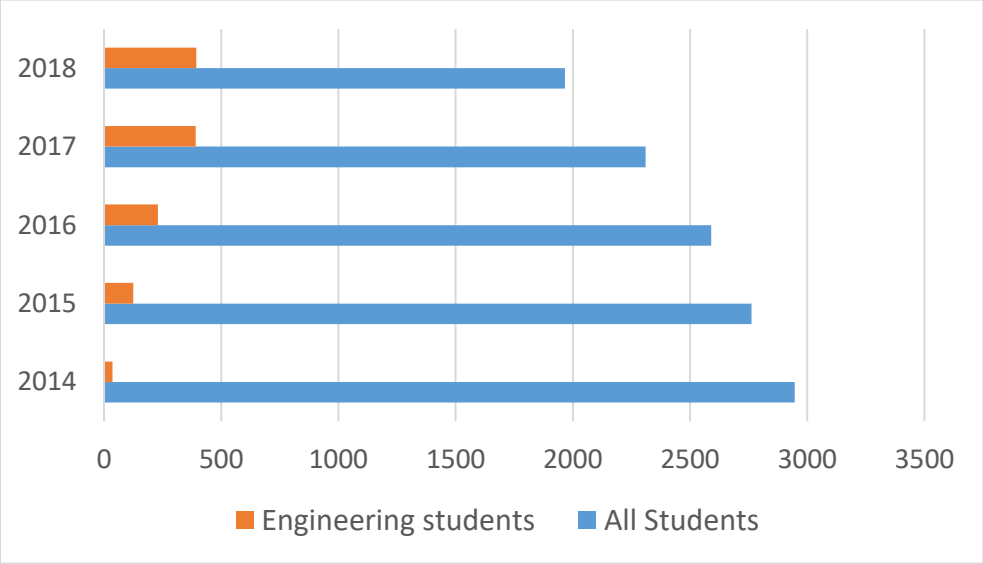

Figure 1: Student population at researcher's all-female institution

Specifically, this research study takes place in a federally-funded HE institution in Dubai, which is one of the seven emirates of the UAE, as mentioned earlier. This institution is exclusively for Emirati females, although the campus has both male and female staff. Almost all of these staff are expatriates and all tuition is given in English. For confidentiality reasons, as

dictated by the local ethical approval granted to carry out this research study, the institution involved in this particular research study will be called *the institution* throughout this research study.

Based on literature mentioned in the previous section of this chapter, this increase in the number of female Emirati students at *the institution* choosing to study engineering is surprising given the previously mentioned Emirati cultural beliefs that discourage Emirati females from interacting with any males outside their immediate family.

1.5 Research questions

As I was interested in uncovering the reasons for this specific group of female students' decision to study engineering, the main research question for this study was:

- What are the reasons for the current Year 1 and 2 engineering students at this all-female institution to study engineering, and how might this inform local, national, and institutional policy?

Further sub-questions were:

- What, in the view of current female engineering students, are the factors that influenced their decision to study engineering?
- What insights do staff at this institution bring to the question of why there has been an increase in female students at the institution choosing engineering?

1.6 Purpose of this study

As there is a lack of research into Emirati females in general (Madsen, 2009), a lack of research into their rationale for making choices related to education (Aswad et al, 2011), and a particular lack of research related to their rationale for choosing STEM-related subjects including engineering (Aswad et al, 2011; Mahani & Molki, 2011) at HE level, the purpose of this research is to add to the field of knowledge related to Emirati females and their STEM-related studies and careers.

Indeed, as the institution where this research took place is situated in the data-driven city of Dubai (Dubai Corporation of Tourism & Commerce Marketing, 2019), it is possible that the results of this research could initiate relatively instant changes to *the institution* to accommodate a rise in the number of female Emirati engineering students, particularly if these changes are positive and contribute towards the UAE government's vision of a knowledge-based economy which promotes "innovation, research, science and technology" (UAE Vision 2021, 2018a). Consequently, this research is not only important for *the institution*, where this current research took place, but also has the potential to contribute on a national level, as the UAE Minister for Foreign Affairs and International Cooperation recently stressed the need for Emiratis to study STEM subjects rather than Business (Malek, 2018), to better support the country's goal of being a knowledge-based economy by 2021 (UAE Vision 2021, 2018a). Although this could be considered a controversial statement as Emirati females have usually had a tendency to choose to study Business in HE up until recent years, with 45% of all females in the UAE graduating with Business majors (Kemp, 2013), this message is clearly part of the government's vision to further develop their country.

Ultimately, it is hoped that this research could also influence other institutions with female students, as well as institutions with all-female campuses across the country, resulting in either similar research being carried out at those campuses or a wider set of engineering courses being made available to Emirati females.

Uncovering some of the reasons for these Emirati females' decision to choose engineering at HE level could also provide support in tailoring future study and career advice to encourage more Emirati females to study engineering and similar STEM-related subjects. Indeed the findings of this research study could have the potential to contribute towards a greater understanding of Emirati female students study pathway decisions in HE in general, within the context of Dubai.

Furthermore, the increase in the number of female students choosing to study engineering at this particular institution is also in contrast to the decline of students studying at *the institution* overall, as shown previously in Figure 1.

1.7 Thesis structure

Chapter 1 has outlined the purpose and importance of this research not just locally, but globally too, while also providing the setting and context in which this case study is situated. This chapter also outlines the general structure of this thesis and the research questions on which this research study is based. It introduces the acronym STEM in this context and outlines the researcher's background and assumptions going into this research.

Chapter 2 provides a literature review for this research topic, including the importance of STEM globally and the recognition of the need to encourage more women into STEM-related careers such as engineering to ensure the success of this field worldwide. The chapter also offers a historical perspective on male and female students' performance in STEM-related subjects across different education levels, including HE, and the closing of a perceived gap between these students' abilities in these subjects. It continues with a specific focus on women in STEM in HE and women in STEM-related careers globally. Chapter 2 then provides an outline of STEM and its place in the UAE at the time of this research study, before moving on to Emirati women's access to HE and Emirati women in the workplace.

Chapter 3 offers an overview of the research design and methodology of this research study. It provides the rationale for using a case study in this instance, along with an explanatory sequential mixed methods approach, which includes an online questionnaire followed by a set of semi-structured interviews. This chapter also shares how data was collected and analyzed continuously throughout this research study and explains the methods used in this data analysis. It further mentions how data triangulation is integrated into this study to improve the quality and density of the data collected in this study overall.

Chapter 4 presents the findings of this research study, both quantitative and qualitative, and shares some of this information through the use of graphs and charts, where it is relevant and pertinent to do so. An analysis of some of the findings is also included in this chapter and a figure is included to illustrate the overall findings of this research study.

Chapter 5 is concerned with exploring the research findings of this study and offers a discussion related to these findings in the context of Dubai and the UAE. This chapter provides some suggested reasons for the recent rise in a group of female Emirati students at *the institution* choosing to study engineering and suggests new knowledge which this research has uncovered. It highlights the limitations of this study, while also offering recommendations for practice based on the findings of this research along with recommendations for future research related to this field.

Chapter 6 is the concluding chapter and shares an overall view of the entire research study, answering the research questions while also highlighting the limitations of this research study. It also shares some recommendations for future practice and possible future research studies.

Chapter 2: Literature review

2.0 Introduction

This chapter highlights the importance of STEM globally in current literature, with a focus on women in STEM-related subjects including engineering. Initially, the chapter looks at the performance of both male and female students in STEM-related subjects and then focuses on the indicators that affect women in STEM in HE globally. It then moves to reviewing women in STEM careers before looking at this context in the UAE. Within the UAE context there is limited literature related to Emirati females in general, but particularly related to their choices of HE subject and specifically their HE choices related to STEM-related subjects, including engineering, as mentioned in Chapter 1. Therefore, this chapter reviews the importance of STEM-related subjects in the UAE alongside Emirati women's access to HE since the formation of the UAE and their role in the UAE workforce to-date.

2.1 The importance of STEM globally

As discussed in Chapter 1, as governments around the world recognize the need to move towards the development of knowledge economies to keep pace with increasing globalization, many also recognize the importance of developing human capital to support this. Developing and sustaining a knowledge economy requires a strong focus on education along with research and development (Kumar & Van Welsum, 2013), both of which can be supported in HE, but specifically through STEM subjects in HE. Indeed, in the USA it has been recognized that a lack of STEM graduates has the potential to negatively affect the country's long-term economic and political progress (National Academy of Sciences, 2003, cited in Fox, Sonnert, & Nikiforova, 2011).

Recognizing the importance of STEM has led to global initiatives which specifically promote STEM and encourage students to study and engage with these subjects in countries including Australia, Hong Kong, Malaysia, and the USA (Australian Government Department for Education and Training, 2018; Education Bureau, 2016; Ministry of Education Malaysia, 2013; US Department of Education, n.d.). International organizations have also launched initiatives to

specifically encourage more women into STEM in general, and engineering in particular, including the InterAcademy Council (IAP), the European Commission through the Helsinki Group, and the United Nations (UN) through the United Nations Educational, Scientific and Cultural Organization (UNESCO) (Sengers, Shanahan, & Castillo, 2008). In addition, one of the strategic objectives of the World Federation of Engineering Organizations (WFEO) is to "promote diversity and inclusion in the engineering profession" (World Federation of Engineering Organizations, 2015, p 4) to encourage more women to enter the field, ensuring its prominence as one of the main organizations promoting engineering as a profession to women and reinforcing the fact that women are vital to the field's future success (Rohatynskyj, Davidson, Stiver, & Hayward, 2008).

The relevance of promoting engineering is evident given that, although the number of female STEM graduates has increased in recent decades, the majority of these female STEM graduates have majored in natural sciences such as biology in multiple countries around the world including Australia, Canada, the UK, and the US (Marginson et al, 2013; Hill et al, 2010). Indeed, of the 88,371 science and engineering Bachelor's degrees awarded to women in the US in 2007, only 2.38% of these degrees were in electrical engineering, while 54% were in biology.

2.2 Performance of males and females in STEM-related subjects across different educational levels

Although early studies suggested that, globally, boys outperformed girls in STEM-related subjects such as Math and Science in primary and secondary schools (Beller & Gafni, 1996), gradually over time this gap appears to have diminished in many countries including Thailand (Knodel, 1997), the USA (Voyer & Voyer, 2014), and the UK (Skipper & Leman, 2017). Reasons for this could be related to a general rise in gender equality or an awareness amongst educators of the need for equity in the classroom. Certainly, evidence now shows there is frequently little difference between male and female students' performance in STEM-related subjects such as science (OECD, 2016) and in some cases, such as Finland, females have even outperformed males in the same subject (OECD, 2016).

The closing of this gap between male and female students' STEM performance does not appear to be related to any one specific educational approach, as students in both egalitarian and hierarchical countries such as Finland and Korea have equally high levels of female students studying STEM subjects at secondary school level (Marginson et al, 2013). Therefore, although these educational systems have potentially been influenced by their countries' different social and political cultures, the difference in STEM abilities by gender is negligible.

2.3 Fluctuation in number of students opting to study STEM-related subjects

Although the gap is now less apparent between the number of male and female students studying STEM subjects overall, Sjøberg and Schreiner's (2005) ROSE (Relevance of Science Education) project uncovered a decline in the number of 14-16 year old students opting to study STEM subjects in developed countries, regardless of gender, while the opposite appears to be true in developing countries.

Indeed, even at tertiary level in the European Union (EU), the number of both male and female graduates of "science, mathematics and computing" has dropped from 12% to 9% since 2000 (European Commission, 2012). By contrast, in 2013 the number of STEM graduates in China was 40% with 4.7 million graduates, while India followed with 2.6 million graduates (McCarthy, 2017). Regardless of this growth of STEM graduates in these two countries overall, although they have the largest number of STEM graduates by country globally, female engineers in these countries are still in the minority.

2.4 Indicators for lack of women in STEM in Higher Education globally

Regardless of the diminished gap between male and female students' performance in STEM-related subjects, there still appears to be a lack of females choosing to study STEM-related subjects in HE in general (Archer et al, 2013; Hill et al, 2010; Marginson et al, 2013; Smith, 2010) and engineering in particular (Bystydzienski & Brown, 2012; Gill, Mills, Franzway, & Sharp, 2008; Rohatynskyj et al, 2008). This general lack of females has been referred to as a leaky pipeline, as the number of female students drops consistently from primary school all the way through to tertiary level education (Hill et al, 2010). Instead, it would appear that female

students predominantly opt to study subjects such as Education or Humanities and Arts (OECD, 2012a, cited in Marginson et al, 2013) at the expense of STEM-related subjects.

Across the EU, male graduates still predominate in mathematics and engineering, with only one in four engineering graduates being female (European Commission, 2012). Even in Finland, where the government takes an active role in promoting women in science, the HE subject with the lowest number of female students is technical sciences at 20% (Kurki, Kuusi, & Vänskä, 2001). Considering that some regions such as the EU have more women than men enrolled in HE in most of their countries, with 124 women enrolled on average for every 100 men (European Commission, 2012), this is potentially a lost opportunity for females to further contribute towards STEM-related fields. A similar situation is taking place in the USA where, even as recently as 2014, only 19.8% of all engineering Bachelor's degrees were awarded to women (National Science Foundation, 2017) even though 58% of undergraduates across all fields were female (Fox et al, 2011).

Some studies have suggested that this lack of females studying STEM-related subjects in HE could be related to self-efficacy (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Powell & Boyd, 2012; Rodd, Reiss, & Mujtaba, 2014). Certainly, perceived self-efficacy can be seen as a significant contributor to the choice of any HE or career pathway as Bandura and colleagues (2001) found that people will not make choices where they do not believe they have the power to achieve in this regard (Bandura et al, 2001). Conversely, if individuals believe they have the power to achieve their own personal projects, they are more likely to make study and career choices that lead them to these aspirations (Bandura et al, 2001).

Although Bandura and colleague's (2001) study related to self-efficacy was undertaken with 272 High School children between the ages of 11-15, in their Italian context this is the age at which children make an important life choice between seventeen different educational pathways, leading to the career pathways they are most likely to follow into adulthood. It is worth noting that this study was carried out with both male and female students. Through their longitudinal study they concluded that although socio-economic status had no influence on the children's perceived self-efficacy, the children's parent's self-efficacy related to their

ability to influence their children's academic pathways was significant. Indeed, they found that parents' aspirations for their children's academic pathways had a profound influence in turn on their children's self-efficacy, with children with a high academic efficacy believing they would be successful in science and technology, regardless of their academic standing at the time of the research study (Bandura et al, 2001).

They also found that male students had a higher self-efficacy related to mathematics than females, and male students had a higher self-efficacy related to careers in science and technology (Bandura et al, 2001). As their study showed the significance of parental influence on these students' self-efficacy in general, Bandura and colleagues (2001) theorized that this could be due to parental influence related to gender-linked beliefs and, specifically, these parents' beliefs that girls are less capable in mathematics than boys (Bandura et al, 2001). The significance of this parental influence also extended to occupational self-efficacy, with Bandura and colleagues (2001) concluding that in terms of occupational self-efficacy, careers traditionally seen as stereotypically specific to one gender or another in this particular country were reinforced, with girls tending to opt for careers in nursing and boys tending to opt for combat careers in the military.

Besides self-efficacy, another documented reason for a lack of females studying STEM-related subjects has included a conflicting view of their own identity in relation to STEM-related careers (Archer et al, 2013). In Archer and colleagues' (2013) study of over 9000 male and female children aged 10-14 across the UK, they concluded that social factors were largely influential in deterring female students from opting to study STEM-related subjects. Although almost all of the females in the study enjoyed studying STEM-related subjects, they were reluctant to choose to follow STEM careers as their view of the identity of STEM roles in the workforce was incongruent with their own personal identities, based on their gender identity (Archer et al, 2013).

A further reason for low numbers of females studying STEM-related subjects may also be related to society's perception of STEM in general (Marginson et al, 2013; Skipper & Leman, 2017), and/or the fact that female students may have a wider range of alternatives to study in

HE besides STEM, which their male counterparts do not necessarily have (Ceci & Williams, 2010). Indeed, related to this, it has been suggested that the significant number of male students choosing to study engineering in the West could be due to males opting for a default gender choice of subject based on their conventional view of engineering as being suited to males, as well as their lack of awareness of other subjects available to them (Walker, 2001). By contrast, in the same setting, females who chose to study this subject were perceived as challenging "traditional boundaries" (Walker, 2001, p 81).

In Christie and colleagues' (2017) Australian research study facilitated through focus groups, some of the reasons which female students at their institution gave for not studying STEM subjects included *misconceptions about science*, *self-doubt*, *doubts about where a STEM career would lead*, and the fact that *STEM jobs are male-dominated* (Christie, O'Neill, Rutter, Young, & Medland, 2017). By contrast, in Kho's (2016) research study facilitated through an online survey across two institutes in Malaysia and Kazakhstan, despite the differences in the historical and cultural backgrounds of the two countries, he found that one of the reasons his female students had chosen to study engineering was a strong awareness of the job opportunities available to them as engineering graduates. Although it is outside the scope of this research study, these two studies could suggest that more female students would opt to study STEM subjects such as engineering if they were better informed about the career options and job opportunities available to them on graduation.

Further reasons for the lack of females choosing STEM-related subjects included parental influence (Powell & Boyd, 2012; Skipper & Leman, 2017) and /or the influence of teachers (Powell & Boyd, 2012) who Dick and Rallis refer to as "socializers" (1991, p 283). In their research, Dick and Rallis highlight the fact that this influence can be "subtle yet extremely powerful" (1991, p 291), but they also stress the need to carry out further research to discover at which age this influence potentially has the most impact. Although Dick and Rallis' (1991) study was based in the USA and is now relatively old, their study still has value in the context of this research study as the *socializers* they refer to can still be seen as maintaining an influence today. Indeed, this study is worthwhile to refer to as the survey they administered followed on

from previous research carried out by other researchers (Rallis & Ahern, 1986, cited in Dick & Rallis, 1991) and provides strong evidence to support the idea of *socializers* in general (Dick & Rallis, 1991), regardless of the cultural milieu surrounding the study.

Meanwhile, in their research, Fox, Sonnert, and Nikiforova (2011) highlight the fact that women tend to choose engineering in the USA based on individual or structural factors. They categorize these individual factors as those related to women's "attitudes, values, aptitudes, experiences, and/or behaviors" (Fox et al, 2011, p 592), and structural ones as those related to the environments which women are exposed to during their education and/or work in science and engineering i.e. whether they are inclusive/exclusive, masculine/feminine, competitive/collaborative. Fox and colleagues' (2011) research indicated that institutions tended to focus on structural definitions to explain the lack of females in engineering rather than individual ones.

By contrast Matusovich, Streveler, and Miller (2010) suggest that values have a strong influence on female students' decision to study engineering. Their study draws on the expectancy-value theory (Eccles, 2005, 2007, cited in Matusovich et al, 2010) which suggests that students make decisions based on either their competence or value beliefs. Accordingly, a student's competency belief would be related to whether or not they believe they have the ability to study engineering, while their value belief would relate to how much personal importance they place on studying this subject.

In their review of 30 years of research from across psychology, sociology, economics, and education in the US, Wang and Degol (2017) also referred to expectancy-value theory as important, along with mind-set theory which posits that females are more likely to believe that innate intelligence is required to be academically success in math. However, they also suggest that a "more global social cognitive approach" (Wang & Degol, 2017, p 120) is needed to explain the lack of women in math-intensive fields such as engineering, including exploration of both females' ability to study these subjects, in addition to their motivation to engage with careers in these fields. Consequently, they suggest that beyond an ability to be able to engage successfully with these STEM subjects, females also need to be interested in them too. Wang

and Degol (2017) further propose that possessing one ability that is particularly stronger than any other abilities a person has can be a factor when deciding on their study or career pathways. Correspondingly, having strengths in multiple areas can provide more options, which can also result in a person's study or career choice being based on interests rather than purely ability. Considering this theory, Wang and Degol (2017) suggest that as women tend to be symmetrically strong in both verbal and math skills, they have more options available to them and, therefore, this may be one of the reasons they tend not to choose math-intensive STEM subjects. This aligns with Ceci and Williams' (2001) findings mentioned earlier, which found that females may have more options to choose from in HE besides STEM subjects.

When focusing specifically on the STEM subject of engineering, Bystydzienski and Brown (2012) suggest that the gendering of engineering as a largely technical subject also deters females from choosing to study it. Indeed, Walker (2001) has suggested that a lack of women in engineering could be related to the continued view that it is a masculine subject. Rohatynskyj and colleagues (2008) support this viewpoint and further suggest that this is due to technology being identified as masculine. This sentiment is also confirmed by Wajcman (2010) who highlights the fact that the language and environment of engineering in Western societies can still be considered predominantly masculine which, in many cases, requires women to adapt a masculine identity to be part of this field, while no similar expectations are placed on men.

To some extent, this situation has also been perpetuated by tertiary institutions around the world. Examples of these include the Massachusetts Institute of Technology (MIT) in the USA (Rosser, 2003) and the Escuela Politécnica in Ecuador (Munoz & Weaver, 1997). Certainly, despite conferences on women in science and engineering being held at MIT in the 1960s (Rossi, 1965; Bix, 2000), a general lack of support for women studying engineering at this institution continued for decades (Bix, 2000). It was not until January 2001 that MIT issued a statement, along with eight other highly regarded American HE institutions including Harvard, Stanford and Yale universities, recognizing the fact that there were still barriers to female students studying STEM subjects at their institutions and the need to address issues related to

this situation (Rosser, 2003). In the case of Escuela Politécnica, despite dramatic increases in their female student population, with women constituting "more than 70% of total enrollment growth between 1978 and 1987" (Munoz & Weaver, 1997, p 81), the attrition rate of female students in STE-related programmes was also significant. In their study, Munoz and Weaver (1997) found that some of the reasons for this high attrition rate was due to hostility from male professors and male students towards the female students in these programmes. Fortunately, as a result of this study, these issues were brought to the fore and raised an awareness of the need to accommodate these female students in future at this institution (Munoz & Weaver, 1997).

It has also been suggested that the current state of fewer women than men in engineering in Western countries could be related to the Western meta-narrative surrounding engineering whereby it is largely considered to be male-dominated, as discussed earlier (Rohatynskyj et al, 2008). However, even in some Southeast Asian countries which may not considered to be dominated by this narrative, such as Indonesia and Cambodia, statistics equally show that there are still fewer women than men studying engineering in HE overall (UNESCO, 2006).

In Indonesia, it was reported that only 18.8% of women were studying industrial engineering at HE level in 2003 (UNESCO, 2006). In a report on gender, science and technology in five Asian countries it was suggested that Indonesian women did not choose engineering as it was a subject "more suited for boys" (UNESCO, 2006, p 15). Nonetheless, this statement is in direct contrast to the Indonesian government's strategic policies to achieve gender equality in science and technology, provide support "to increase opportunities for girls to continue to (…) participate in science and technology education" and increase "women's knowledge of the application of appropriate technologies with a gender perspective" (UNESCO, 2006, p 39).

Similarly, in Cambodia the number of female undergraduates studying engineering amounted to only 10.79% in 2004 (UNESCO, 2006). This is likely to be related to the social belief that "females are by nature technologically ignorant and unable to absorb scientific and technological know-how" (UNESCO, 2006, p 54). Again, this contrasts starkly with the

Cambodian government's strategic goal to promote women's rights and "ensure that women (…) gain full rights in education and skills training at all levels" (UNESCO, 2006, p 31).

By contrast, one Asian country which is also unlikely to relate to the Western narrative around engineering, given its diverse history, traditions, and culture (Rohatynskyj et al, 2008), but is the exception in terms of female student enrollment in engineering is China, where in 2004 just over 36% of engineering students were female (UNESCO, 2006). Although this is still lower than the number of males studying the same subject, it is significantly more than in other Asian countries. It has been suggested that this could be due to the strong gender equality policies promoted during the Maoist regime in contrast to the Western meta-narrative discussed earlier (Rohatynskyj et al, 2008). It has also been proposed that these engineering figures could be related to policy initiatives undertaken by the Chinese government in more recent times (Rohatynsyj et al, 2008).

It is worth noting that documented reasons for other Middle Eastern Arab females' decision to study engineering have included a change in economic circumstances, the perceived level of prestige associated with studying engineering, and a "relaxation of societal norms" (Matthews, 2013, p 33). However, this is not consistent as cultures can still differ across Middle Eastern countries (Aswad et al, 2011; Matthews, 2013).

2.5 Women in STEM careers globally

As a result of the low numbers of female students opting to study STEM at HE, the number of existing female STEM graduates available to choose STEM-related careers has also been affected (Blickenstaff, 2005; Ceci & Williams, 2010; Hill et al, 2010). In 2006 in the USA, only 10% of employed engineers were female (Bystydzienski & Brown, 2012), while as recently as 2017 only 11% of the UK's engineering workforce was female (WISE, 2017).

Apart from being a waste of female talent (Blickenstaff, 2005; Walker, 2001), an additional repercussion from this situation is a lack of female input and female voice in STEM-related fields (Beede et al, 2011; Blickenstaff, 2005; Hill et al, 2010). Specific examples of this include early voice-recognition systems only being calibrated to identify male voices and early

airbags only designed for adult male bodies, resulting in the avoidable deaths of women and children whose body types they were not designed to accommodate (Margolis & Fisher, 2002, cited in Hill et al, 2010). Indeed, industries such as Motorola have since recognized the need to recruit HE graduates with strong interpersonal and communication skills, which are typically considered to be female characteristics (Walker, 2001).

2.6 STEM and the UAE

Globalization has affected the UAE dramatically (Abdulla, 2005), with the country moving from an almost completely rural society to a predominantly urban one in just one generation (Marmenout & Lirio, 2014), following the discovery of oil in the 1950s (Butt, 2001). Throughout this, the UAE has embraced globalization, developing at an unprecedented pace to compete with other countries globally within a short space of time. To enable this growth, the UAE has sought out best practices from around the globe and encouraged world-class talent to contribute to the country's growth (UAE Vision 2021, 2018a). Initially, this talent was required to support the building of the country's infrastructure while simultaneously educating the indigenous population (Burden-Leahy, 2009) to be able to develop their own country over time. As a result of this strategy, 88% of the UAE population is currently expatriate (Indexmundi, 2018). This situation is unlikely to be reversed, as a World Bank report stated that the threshold by which Emiratis could now constitute the majority of the workforce has now passed (Ruppert, 1999, cited in Burden-Leahy, 2009), as mentioned in Chapter 1. Although it may no longer be possible to reverse the situation whereby the majority of the workforce in the UAE is expatriate, the UAE government can still focus on employing as many Emiratis with the ability and aspiration to be employed as possible, to go some way towards rectifying the current imbalance of expatriate to Emiratis in the workforce.

A significant element of the UAE government's vision for the country is to move towards the creation of a knowledge-based economy by 2021, with "innovation, research, science and technology" as the pillars of this economy (UAE Vision 2021, 2018a). To achieve this vision, encouraging more Emiratis to study STEM subjects has now become a national priority, with several policies initiated by the UAE government to promote STEM throughout its education

system, including the Emirates Science, Technology and Innovation Higher Policy launched in 2015, which focused on developing STEM across all levels of education (Government.ae, 2019e). Possibly as a result of this policy, in the same year the emirate of Abu Dhabi, which is also the capital of the UAE, announced significant changes to their school curriculum, ensuring that 50% of High School students' subjects were STEM-related (Pennington, 2015). Following this, in 2016 the emirate of Dubai introduced sweeping changes to their High School curriculum too, with a stronger focus on STEM-related subjects in general, and high-performing students moved into an advanced Math and Science stream from Grade 7 (Pennington, 2016). Indeed, in addition to these policies related to education, as part of their sustainability goals aligned with the UN's sustainable development goals (SDG), the UAE government also seeks to improve students' math and science abilities with the aim of being placed among the 20 highest ranked countries in these subjects by 2021 (UAE National Committee on SDGs, 2017). The government's drive towards sustainability also aims to increase the number of knowledge workers to 40% of its total workforce by 2021 (UAE National Committee on SDGs, 2017).

Taking into account the fact that the UAE workforce is now predominantly expatriate and that this is unlikely to change, it is more important than ever for Emiratis of both genders to join the workforce and contribute to the development of their country in order for the government's vision to be realized (UAE Ministry of Human Resources & Emiratisation, 2018a; UAE Vision 2021, 2018a). Unfortunately, one drawback of having such a large expatriate population is that the job market has also become increasingly competitive for Emiratis (Forstenlechner, Madi, Selim, & Rutledge, 2012; Marmenout & Lirio, 2014). Therefore, to improve this employment situation for the indigenous population, the UAE government has created an Emiratisation programme to promote the employment of Emiratis within all sectors of the UAE labour market (UAE Ministry of Human Resources & Emiratisation, 2018a), as briefly mentioned in Chapter 1. This Emiratisation programme also includes the implementation of laws to ensure that the number of Emiratis employed across various sectors is adhered to (UAE Ministry of Human Resources & Emiratisation, 2018b).

As the UAE government believes that harnessing all Emiratis' talent is vital to ensuring the success of a knowledge economy (UAE Vision 2021, 2018a), it also stresses the importance of equity in the workplace, with women being given equal opportunities so that they too can play a role in the development and success of the UAE economy (Gallant & Pounder, 2008; Marmenout & Lirio, 2014). Therefore, encouraging female Emiratis to pursue STEM subjects in HE, particularly engineering, has gained even more importance as Emirati female students currently outnumber Emirati males throughout all federal government HE institutions (Bennett & Wright, 2010).

As mentioned earlier, there appears to be a drop in the number of students in developing countries choosing to study STEM-related subjects. This is particularly the case with a lack of women choosing to study engineering, which could be associated with the Western meta-narrative surrounding this field, as previously discussed. To reiterate, this research study is concerned with female students in one institution in Dubai in the UAE. Although the UAE has been officially described as a developing country (United Nations, 2015), in some literature it has also been labelled as a rentier country, suggesting that its economy is unsustainable as its revenue is largely based on its oil windfall (Burden-Leahy, 2009). In this regard, Burden-Leahy (2009) suggests that being labelled as a rentier state is also damaging the UAE's efforts to establish itself as a nation beyond the extraction of oil, as rentier states can be inclined to focus on the short-term rather than the long-term view of the economy. Furthermore, despite the support and funding of HE for all Emiratis as a result of the UAE's oil revenue, the World Bank (cited in Burden-Leahy, 2009) argued that the bulk of these graduates produced no economic value, but instead sought shelter in predominantly public sector jobs, which served to hide the country's unemployment issues. This may be something to consider in the overall findings of this research.

2.7 Emirati women's access to Higher Education

The rate at which education has developed in the UAE is considerable, especially allowing for the fact that illiteracy was estimated to be at 98% in this region in the 1950s (Krause, 2008). Since the discovery of oil and the formation of the UAE in 1971, education has

been one of the main priorities of the UAE government (Peck, 2001). Indeed, prior to its formation the UAE had virtually no educational infrastructure (Burden-Leahy, 2009) and illiteracy rates were sizeable, particularly amongst women, who accounted for only 4% of the literate population in 1970 (Krause, 2008). To remedy this situation the UAE government created an education system that was free and accessible to all its citizens (Abdulla, 2005) from primary school through to High School. Although, initially, Emirati males appeared to be the main beneficiaries of this new education system, with women only accounting for 47% of High School graduates in 1987 (Abdulla, 2005), Emirati females soon began to catch up with Emirati males and even surpassed them in numbers, as mentioned earlier.

While HE has been available in the western world for centuries, even up until the end of the nineteenth century women still struggled to access quality education otherwise available to men (Hamilton & Schroeder, 2007). Since that time, women's access to HE has improved considerably, with female graduates on a par with male graduates in many countries throughout the world, such as "Argentina, Canada, Western Europe, Finland and Russia" (Marginson et al, 2013, p 134).

In the case of the UAE, as it is such a young country, having only been formed in 1971, its national HE system was also established relatively recently, in 1977 (Burden-Leahy, 2009). Although the first university, which was UAE University, was set up for male students only, it later opened to females (Burden-Leahy, 2009). UAE University (UAEU) now currently offers a wide variety of disciplines to both Emirati and non-Emirati students including several engineering majors, which are accredited by UAE Commission for Academic Accreditation (CAA) (UAE University, 2019). Although UAEU is based in the emirate of Abu Dhabi, it provides accommodation to students on-site, resulting in a broad student demographic who are subsequently employed across the UAE and abroad upon graduation. It is worth noting that only international students are required to pay fees at this institution.

Subsequently, due to the high demand from Emirati females to be able to access HE, Zayed University opened as an all-female campus in 1998 (Burden-Leahy, 2009). This university currently offers Bachelor's degrees in a wide variety of disciplines, with an emphasis on

scientific research, but does not offer engineering courses beyond software engineering. As a HE institution, it is accredited by the US Middle States Commission on Higher Education (Zayed University, n.d.).

In addition to these institutions, the Higher Colleges of Technology (HCT) was established in 1987, initially offering HE to males and females at four segregated campuses (Burden-Leahy, 2009) and later expanding to seventeen campuses across the UAE making this institution the largest HE institution in the UAE. In the case of HCT, approximately 100 majors are now offered across the seventeen campuses (Higher Colleges of Technology, 2019a), with the programme offerings at each campus reflecting the needs of the labour market in that particular emirate. Subsequently, although each campus offers core subjects such as Business, specialist programmes such as Marine Engineering are only offered in campuses where there is a need for graduates in these particular majors in this emirate. All engineering programmes at this institution are accredited by the UAE CAA and five of these engineering programmes are also accredited by the global Accreditation Board for Engineering and Technology - Engineering Technology Accreditation Council (ABET-ETAC) (Higher Colleges of Technology, 2019b).

Beyond these three federally-funded HE institutions, there is a plethora of private fee-based universities across the country including satellite universities from prestigious global universities such as New York University from the US, the Sorbonne from France, and Middlesex University from the UK.

In contrast to the number of HE female graduates in other countries, which are now comparable to males globally, since the opening of these three federally-funded institutions Emirati female students now outnumber males throughout the UAE HE system, as mentioned previously. It is worth noting that Emirati students can attend these HE institutions without paying any fees, which creates a situation whereby all indigenous members of Emirati society have the opportunity to access HE (Shihab, 2001).

Despite this difference in enrollment figures between Emirati males and females, there is still a documented shortage of Emirati females studying STEM-related subjects such as engineering in HE (Mahani & Molki, 2011). This potentially deprives the UAE of half of their

STEM-related talent in this field, in contrast with the UAE government's vision to develop a knowledge-based economy to promote innovation, research and development by 2021.

As mentioned in Chapter 1, it is noteworthy that there is still a lack of research into Emirati students in general, and females in particular. There is also a gap in the literature related to the factors behind Emirati students' reasons to study STEM-related subjects in general, including a dearth of literature uncovering the reasons for Emirati women, in particular, to choose to study STEM-related subjects such as engineering at HE level.

2.8 Emirati women and the workplace

As discussed earlier, the UAE government has an Emiratisation initiative in place to ensure more Emiratis have the opportunity to be employed in the UAE workforce. However, despite this initiative, in addition to providing free education at all federally-funded institutions and encouraging Emirati females to play their role in the growth of their country, there is still a discrepancy between HE and employment statistics. In 2003, 75% of the UAE HE population were female, but only 14.7% were actively employed (Abdulla, 2006).

One reason for this could be linked to UAE society still dictating that a female's role is primarily familial (Gallant & Pounder, 2008; Marmenout & Lirio, 2014) and their relatives still have considerable influence over both their HE and career choices (Al-Darmaki, 2012; Kemp & Zhao, 2016). Indeed, in Gallant and Pounder's (2008) literature-based study which sought to uncover the reasons for the low employment of Emirati women, despite having considerable support from the UAE government, they found that family pressures for Emirati women to maintain a home environment were a contributing factor. In their paper they quoted a prominent manager of a Dubai-based charity as saying: "Women are not asked to pay for their families, they are only asked to look after them" (Al Nowais, 2004b, cited in Gallant & Pounder, 2008, p 29), suggesting the traditional view that a women's place is in the home, not in the workplace.

Similarly, in Marmenout and Lirio's qualitative study which explored the issue of Emirati women's retention in the domestic workforce, they concluded that although the Emirati

women in their study viewed working as natural, Emirati society was "still ambivalent about the condition of working women" (2014, p 151). The participants in their study also shared the issue of maintaining a family-work equilibrium, as the role of rearing children was largely considered to be the responsibility of females (Marmenout & Lirio, 2014).

However, although the view may still be held that Emirati women should maintain the responsibility of primary caregiver to their children, unlike other countries around the world Emirati women are in a position to delegate some of this responsibility to domestic help such as maids, nanny and/or drivers, as this is prevalent and acceptable throughout Emirati society. To illustrate, in 2016, 306,000 domestic workers were employed in the UAE with an annual growth in this sector of 8.8% (Tayah & Assaf, 2018). Not only does this illustrate the prevalence of domestic workers in UAE households, it also suggests a trend that is likely to continue.

Besides child-rearing, it has also been suggested that although the government strongly encourages Emirati women to study, traditional Emirati families still only consider HE to be an acceptable way to spend time prior to marriage, as it takes place in an all-female environment, while employment can be deemed to be inappropriate (Burden-Leahy, 2009) as females are likely to be interacting with males outside of their family.

Whatever their own personal ambitions to fulfil their role in society post-graduation, it may also be the case that some Emirati females decide not to engage in employment outside the family home due to perceived, rather than explicitly stated, familial expectations that they should be involved in child-rearing while males are expected to be the main breadwinners (Abdulla, 2005).

Furthermore, although the drive to replace Emiratis in all sectors of the economy exists, many Emiratis continue to opt for public sector jobs instead of seeking employment in the private sector. In the case of Emirati females, this could be linked to their families' decision to approve their workplace (Gallant & Pounder, 2008; Marmenout & Lirio, 2014) based on whether or not they deem it to be culturally acceptable.

Looking at employment statistics in 2017, 7.19% of the total UAE workforce was Emirati, but only 3.38% of the private sector were UAE nationals (UAE Vision 2021, 2018b). As the public sector is more appealing to Emiratis, employment in this area has now become more competitive and in many cases there are no longer employment options available in this sector, leading to a further reason for so few Emirati females to be employed.

Therefore, while the UAE government attempts to persuade more females to enter all sectors of the workforce, but particularly STEM fields, to contribute towards the development of the country, ultimately it appears that Emirati families still have some influence over whether or not this happens and which sector their female relatives eventually work in. Nevertheless, this may change in the future as the number of female HE graduates continues to exceed the number of male graduates in the UAE (Gallant & Pounder, 2008; Marmenout & Lirio, 2014) leading to a potential social impact on the country (Findlow, 2013), as mentioned in Chapter 1.

Finally, as mentioned in Chapter 1, it is also worth considering the impact which the geo-politics of the region has had on the psyche of the UAE population. The ongoing war in Yemen, along with the breakdown in relations with Qatar have contributed to the recent programme of mandatory military service. Although this military service is voluntary rather than mandated for Emirati females, it is worth considering that this may have contributed to an increased sense of patriotism and desire to contribute towards their country, leading to an increase in Emirati females choosing to study engineering, in line with their government's aspirations.

2.9 Summary

To summarize, although literature suggests that male students have traditionally outperformed females in STEM-related subjects, this gap has reduced over time. Indeed, in many countries around the world it is now documented there is little difference between male and female academic achievements in STEM-related subjects and in some countries females have even outperformed males in the same subject. However, despite evidence to support female students' ability in these subjects, current studies show that there still appears to be a

lack of females choosing to study these subjects in HE. In fact, although there has been an overall drop in the number of both male and female STEM graduates in the EU in recent years, male graduates still dominate. This is unfortunate as a lack of female STEM graduates leads to a lack of female STEM professionals and a lost opportunity for females to contribute in these fields. Indeed, even though STEM graduates have increased in Eastern countries such as China and India, the number of female graduates is still relatively minor compared to the number of male graduates in these countries.

Studies carried out have suggested a variety of reasons for this situation including parental influence, teacher influence and individual or structural factors. It has also been suggested that a lack of females choosing STEM subjects could be due to the perception that engineering is a male-dominated field and/or that females have a wider range of skills and therefore a wider choice of subjects to choose from in HE. Self-efficacy related to STEM subjects could also be a factor in female students' choice of HE major.

In the UAE context, as it is a relatively new country, HE was not introduced until 1977 and at first only for Emirati males. However, in contrast to HE in the West, Emirati females were given access to HE only a few years after Emirati males and now make up the majority of HE graduates. As the UAE strives to keep pace with a globalized world, it recognizes the need to develop all Emirati human capital. Indeed, increasing Emiratisation in STEM-related fields such as engineering is key to diversifying the UAE economy and reducing its dependence on foreign workers, which make up the majority of the UAE workforce. Therefore, in order to achieve their goals of a knowledge-based economy the government has expressed a strong desire for both male and female students to focus on STEM-related subjects in order to realize their vision of a knowledge-based economy by 2021, placing a strong emphasis on encouraging Emirati females to enter these fields to capitalize on the untapped talent of the female population.

Despite this encouragement, it appears that engineering is still considered to be a male-dominated field in the UAE and by Emirati society. Therefore, the significant rise in the number of female students at *the institution* choosing to study engineering initially appears to be at

odds with Emirati traditions and society as Emirati females have traditionally been steered away from male-dominated fields.

Although international research has pointed to some reasons for females in other countries to choose to study or avoid STEM-related subjects, it is worth noting that my research was undertaken without any literature specific to this particular culture, so the UAE setting can be seen as unique in this regard.

Chapter 3: Research design and methodology

3.0 Introduction and overview

This chapter includes my own beliefs related to research, along with the design of this research study and the methods used to collect and analyze the data needed to understand the reasons for the increase in the number of Emirati females opting to study engineering at one particular HE institution in Dubai in the UAE.

3.1 Researcher's beliefs

As a social constructivist, I believe that people make meaning of the world around them through their senses and personal experiences, as described by Guba and Lincoln (1985). My ontological position therefore led to the adoption of a particular epistemological approach to this study, as I sought to understand the reasons why a cohort of female students at this particular campus chose engineering, through a set of questions posed to them about the influences of the world around them, both familial and beyond. Consequently, as the data emerged, I hoped to consider how their views were socially constructed (Lincoln, Lynham, & Guba, 2011).

There were also elements of critical theory (Cohen, Manion, & Morrison, 2011a) in my ontological stance, as I have strong ideals surrounding equity, including the belief of equal opportunities in both education and the workforce, regardless of gender. This may also have influenced my initial decision to undertake this research, as it focused on an all-female context and had the potential to impact UAE HE through the promotion of social change, if further access to HE STEM-related subjects was provided to this institution's students as a result of this study.

Although I view myself as a social constructivist, in this research study I acknowledge that I was pragmatic in my approach to undertake this case study using mixed-methods research (MMR). My rationale for adopting MMR design in this instance was to better

understand the reality of the situation, using quantitative data to provide a general picture of a situation, which could be further explored through a qualitative element (Subedi, 2016).

3.2 Research design – case study

To uncover the reasons for the rise in female students studying engineering at *the institution*, this research took place as a case study, using an explanatory sequential MMR approach (Creswell, 2015) to collect the data. This involved an initial quantitative questionnaire followed by a set of semi-structured qualitative interviews (Merriam, 2009). As I had no information related to the profile of these students, one purpose of the questionnaire was to aid with my understanding of the background of the students I would be interviewing. Another purpose of the questionnaire was to provide information that I could later draw on to build a rapport during the semi-structured student interviews and to signpost potential areas to explore, as there was no specific literature available for me to reference related to potential reasons for these particular students to have chosen to study engineering.

Although I recognize that MMR has been criticized for incorporating different epistemologies within the same piece of research, with quantitative research associated with positivism and qualitative research linked to interpretivism (Teddlie & Tashakkori, 2011), using this approach in this instance had the potential to provide much deeper insight into these students' programme choices. This was due to the fact that a MMR approach in this context provided the opportunity for the quantitative and qualitative aspects to complement each other (Wright & Losekoot, 2012; Silverman, 2010), resulting in a much richer data yield overall.

To uncover the reasons for the rise in female students studying engineering at *the institution*, this research was undertaken as a single-case design case study, with some of the Year 1 and 2 engineering students at this institution as the unit of analysis. Using case study design in this instance allowed for the study to be thorough and responsive, while still being flexible enough to allow for in-depth investigation (Savin-Baden & Major, 2013). It was also relevant in this situation as the unit of analysis was clearly defined, as was the research question, but the findings had the potential to be diverse and far-reaching (Cohen et al, 2011b; Yin, 2009).

This research was carried out with the understanding that there could be multiple factors for these students' decision (Cohen et al, 2011b) to study engineering. Therefore, adopting a case study allowed for inquiry into a particular phenomenon within a real-life context, which could involve multiple contextual conditions (Yin, 2009).

Although I could have theorized that the students' self-efficacy (Bandura et al, 2001), their perceived self-identity in relation to STEM (Archer et al, 2013), their awareness of job opportunities available to them as STEM graduates (Kho, 2016), their family (Dick & Rallis, 1991), and/or society had potentially influenced their decision to choose engineering, based on research carried out in other contexts, the flexibility of a case study allowed for potential changes in direction as the research developed and the reasons for these students' choices unfolded. Adopting a single-case design study was also appropriate as I was concerned with understanding the reasons for a specific group of students' choices in a specific location, which had previously not been researched (Cohen et al, 2011b), making this case study unique. Indeed, as this case study is related to a very particular culture it was also important to keep an open mind as the research I drew on to inform my online questionnaire and interview protocol took place in Western and Eastern cultures, which are quite different from the Emirati culture of Dubai.

Using case study for this research study also allowed for an abundance of factors to be taken into account (Blatter & Haverland, 2012). As case studies can be considered "methodologically eclectic" (Cohen et al, 2011b, p 296), using case study provided the opportunity to incorporate a MMR approach at the data collection stage, along with content analysis and documentary analysis as the data started to emerge. Indeed, to optimize data collection and draw on multiple sources as part of a case study approach (Yin, 2003), methodological pluralism (Moses & Knutsen, 2007) was used.

It is worth noting that, although there is no initial hypothesis associated with this case study, theory is still present throughout as current literature related to potential reasons for other female students' decision to study engineering influenced the questionnaire protocol, which in turn influenced the subsequent set of semi-structured interviews.

To reiterate, the main research question for this study was:

- What are the reasons for the current Year 1 and 2 engineering students at this institution to study engineering, and how might this inform local, national, and institutional policy?

In addition, the further sub-questions were:

- What, in the view of these current engineering students, are the factors that influenced their decision to study engineering?
- What insights do other staff at this institution bring to the question of increasing students at the institution choosing engineering?

3.3 Population, participants, and sampling

As this research was concerned with a specific group of students at one campus, purposeful sampling (Merriam & Tisdell, 2016) was used to identify the students for this study. Although the initial online questionnaire was sent to 152 Year 1 and 2 engineering students from the total cohort of 282 engineering students in all years at this campus, the actual sample for this research study was forty students who completed the questionnaire, giving a response rate of 26.3%. This response rate is similar to other studies where research participants are a self-selecting sample and their participation in an online questionnaire is completely voluntary, such as Abdulla's (2005) research which achieved a 25% response rate and Forgasz, Leder, and Tan's (2014) study where the response rate was 27.9%.

Only Year 1 and 2 students were invited to take part in the research as I believed they were more likely to remember and be able to share their reasons for choosing to study engineering, as it was a relatively recent experience for them in their lives. Although it may appear to be limiting to the research study to only include Year 1 and 2 students as part of the sample, as information is only chosen from a very specific group of students at *the institution*, the rationale for choosing this group was that these students are part of the cohort which specifically contributed to the dramatic rise in engineering students at *the institution*. It is worth noting that, perhaps unlike other institutions around the world where female students may be invited to study engineering, such as in Finland (Kurki et al, 2001), no such barrier

existed for the Emirati females in this study. Indeed, beyond achieving the English language entry requirement, which was the same for all majors offered at *the institution*, the entry requirements for these students to study engineering at *the institution* were the same requirements for entry to any of the other programmes available to them.

Of these forty respondents, fifteen students agreed to take part in a subsequent interview, which is considered an optimum number of interviews to acquire data needed for this research in this instance according to Cohen and colleagues (2011c) and Yin (2008). Of the seventeen engineering staff who were invited to attend an interview, only three accepted and were interviewed. Potential reasons for the low number of engineering staff respondents will be offered in section 3.3.2.

3.3.1 Recruitment of students.

The initial online questionnaire which included 24 questions (Table 1) was sent to all Year 1 and 2 engineering students at *the institution* involved in this research study. These Year 1 and 2 students were identified by the engineering department at my request and a list of their institutional email addresses was shared with me. Students were subsequently sent a link to the questionnaire through their institutional student email address, which enabled the students to be identified through their unique student identification number. As the institutional version of Microsoft Forms was used to administrate the questionnaire, the students' institutional identification numbers were captured when they submitted their responses. This was made clear to the students with a statement outlining this fact at the start of the questionnaire. Students were also assured that any information they shared was confidential and this was further detailed in the Participant Consent Form (Appendix C) and Information Sheet for Students (Appendix D), which were shared with students in both English and Arabic to remove any potential linguistic barriers to understanding. The importance of confidentiality throughout this research study is further discussed in section 3.7.2.

The online questionnaire also operated as a recruitment tool for the second element of this research study as the final question asked students if they would be willing to participate in a short interview. This question was mandatory so students were required to respond to it in

order to complete the questionnaire. The fifteen students who responded positively to this question and agreed to be interviewed were subsequently contacted through their institutional email address and dates and times were set for these interviews. It is likely that the questionnaire also activated these students' schemata in relation to their anticipation of the types of potential questions they could be asked during the interviews (Student #8, Line 54).

The rationale for the inclusion of each of the online questionnaire questions is discussed in detail in section 3.5.1.

Question		**Response type**	**Required response**	**Optional response**
1	How old are you?	Open-ended		✓
2	Do you have brothers?	Yes/No		✓
3	Do you have sisters?	Yes/No		✓
4	Is anyone else in your family currently studying engineering?	Yes/No	✓	
5	Does anyone in your family have a job in engineering	Yes/No	✓	
6	Does your mother work?	Yes/No/*Other*		✓
7	If your mother works, what is her job?	Open-ended		✓
8	Does your father work?	Yes/No/*Other*		✓
9	If your father works, what is his job?	Open-ended		✓
10	Were you in the Arts or Science stream in high school?	Drop-down menu (only one option allowed)	✓	
11	How old were you when you decided you wanted to study engineering?	Drop-down menu (only one option allowed)	✓	
12	Why did you choose Engineering at college? (choose all that apply)	Drop-down menu (multiple answers allowed)	✓	
13	Do you plan to work as an engineer in the future?	Drop-down menu (only one answer allowed)	✓	
14	Which sector do you plan to work in?	Drop-down menu (only one answer allowed)		✓
15	Do you use social media?	Yes/No		✓

16	If you use social media, which of these do you use? (choose all that apply)	Drop-down menu (multiple answers allowed)		✓
17	Did you enjoy Math at school?	Yes/No	✓	
18	How was your Math ability at school?	Drop-down menu (only one answer allowed)		✓
19	Do you think you need good Math to study engineering?	Yes/No/*Other*	✓	
20	Did any of these teachers encourage you to study engineering at college?	Drop-down menu (only one answer allowed)		✓
21	How would you describe engineers? Are they different than any other profession?	Open-ended		✓
22	Do you think engineering is a job that all women can do?	Yes/No/*Other*	✓	
23	Why do you think that more and more students at your college are choosing to study engineering?	Open-ended		✓
24	Would you like to take part in a short interview?	Yes/No/*Other*	✓	

Table 1: Initial online questionnaire questions

3.3.2 Recruitment of staff for interviews.

The recruitment of engineering staff was carried out with the permission of the engineering Division Chair. An email was sent to all engineering staff by the department's administrative officer asking if they would be willing to take part in an interview as part of a research study. This email also contained a Participant Information Sheet for staff (Appendix B) outlining details of the research study along with a Participant Consent Form (Appendix C).

As mentioned earlier, only three engineering staff agreed to be interviewed. Although it is purely speculative, one of the reasons I believe that there was a low uptake in the number of engineering staff willing to be interviewed at this campus was due to their intensive teaching and administrative workload. Unlike other divisions within *the institution* whose students are expected to achieve no more than a maximum of 132 credits to graduate, engineering students have to complete 146 credits to be able to graduate from this division. While this ensures that BAS engineering at this campus is rigorous, adheres to high standards, and is aligned with an accrediting body, it also places a great burden on students and equally places a considerable workload on engineering staff, rendering them little time to participate in research, events, or commitments outside their division. This was confirmed by Staff #1 when they commented on the workload of engineering students compared to other divisions:

> "…the number of coursework the students have to do doubled, tripled, quadrupled in some courses. So it turned out that engineering students are doing <u>much</u> more than other students in other departments." (Staff #1, line 38)

Although this research is directly concerned with the engineering division at this campus, as I am not a faculty member of this division I can speculate that the engineering staff saw this particular research as redundant to their immediate division's requirements.

3.4 Validity and Reliability

To ensure validity throughout this research study and to remove the potential form of "inquirer blindness" bias (Lincoln & Guba, 2000, p 180), through the omission of these students' voices, all Year 1 and 2 engineering students' perspectives were included as the main voice and

primary source of data collected throughout this research. Inviting all Year 1 and 2 engineering students to take part in this research study ensured that no students were excluded from participating, but equally as this participation was completely voluntary there was no coercion either. In addition, including the viewpoint of engineering staff at *the institution* contributed to an overall picture, ensuring data triangulation and potentially avoiding inquirer blindness in this regard too.

To ensure reliability, I consulted with a member of staff on both the student questionnaire and the first version of the student interview questions prior to their administration. In the case of the online questionnaire this included checking not only its readability and the identification of any irrelevant or omitted questions to ensure its overall reliability and validity (Cohen et al, 2011d), but also whether the link to the questionnaire was valid and accessible. This was done by sending the link to a member of staff with a strong awareness of both the cultural nuances and linguistic ability of the students who would receive the questionnaire. Although all instruction at *the institution* is given in English, as mentioned in Chapter 1, I believed it was still necessary to ensure there were no linguistic barriers preventing the students from responding, as almost all of the students' first language is Arabic.

Conversely, checking the interview script was vital to ensure that interviewees were given suitable question forms to be able to respond appropriately. This was also carried out through consultation with this member of staff, stopping to analyze the type of response which the interview protocol was trying to capture while also ensuring that the linguistic level of the interview questions were appropriate for the target student interviewees.

My decision to consult on both the questionnaire and interview protocol with a member of staff rather than a student was twofold. Firstly, I could not run a pilot with any of the Year 1 and 2 engineering students as these were my target research participants. Secondly, my position within this campus could have been seen as influential when engaging with students from other divisions about the engineering programme. By consulting with a member of staff from neither my department nor the engineering department, I hoped to remove any perceived conflict between my role as researcher and member of the campus management team,

removing any perceived possibility of promoting engineering to non-engineering students. Indeed, by selecting a member of staff from a different department for this process I hoped to remove any speculation that this research was designed to reduce the number of students entering engineering or to either encourage or discourage students from studying any other specific BAS programmes.

To ensure trustworthiness, as introduced by Lincoln and Guba (Schwandt, Lincoln, & Guba, 2007), their four criteria of credibility, transferability, dependability and confirmability were observed as follows:

- Credibility: To add credibility to this research I engaged in "peer debriefing" at the midpoint of this research study, both with peers from other divisions at my campus and as a doctoral candidate through the UoL online conference presentations to "test [my] emerging design" (Schwandt et al, 2007, p 19). Furthermore, data triangulation took place through staff interviews and documentary analysis, ensuring different sources and methods were used to gather the information necessary to be able to interpret and draw conclusions. The documents used in the documentary analysis included figures from a variety of institutional document sources to confirm the number of students at *this institution* in both engineering and other divisions in recent years. Other documents included UAE government policy documents related to education, moving towards a knowledge-based economy, and sustainability. In addition, the research methods used throughout this study were well established by other researchers (Shenton, 2004) and as an insider researcher (Becher & Trowler, 2001) at *the institution* I was already familiar with the organization and culture of the students where this research took place (Shenton, 2004).
- Transferability: Using MMR throughout this research study contributed to a much richer set of data collected overall. However, as this research took place as a case study, with a specific group of people in a specific location, it is unlikely that the findings are generalizable to other contexts (Cohen et al, 2011b). Nevertheless, as this descriptive data is an example of one context which could be considered as part of a wider group

(Shenton, 2004), it could still have the potential to be used by others in their own research (Schwandt et al, 2007) if they identify the findings as similar to their own (Shenton, 2004), possibly even informing and influencing their own institutional policy.

- Dependability & confirmability: These criteria have been observed in the overall design of this research and through the inquiry decision taken to understand the reasons behind this recent rise in students opting to study engineering (Lincoln & Guba, 2000) through MMR as part of a case study. In addition, each element of this research study has been clearly documented so that a similar research study could be replicated in future, although with potentially different results (Shenton, 2004). Furthermore, in Chapter 1 of this research study I laid out my positioning within this research along with my overall assumptions which should contribute to the robustness of this study by eliminating any investigator bias on my part (Shenton, 2004).

3.5 Data collection

As mentioned earlier, data collection throughout this research study was undertaken using an explanatory sequential mixed methods approach (Creswell, 2015), with an initial quantitative questionnaire delivered via email to Year 1 and 2 engineering students at *the institution*. One purpose of the questionnaire was to gather data to inform the students' academic and familial profiles, while also exploring potential influences on their choice of engineering, and their willingness to be interviewed. The subsequent, and primary purpose of the questionnaire, was to inform a set of questions for semi-structured qualitative interviews (Merriam, 2009) with some of the students who were identified through the questionnaire. Indeed, as the research progressed it transpired that the bulk of the data which informed this research was in fact gained from the interpretive approach of the latter element, although this was informed by the initial questionnaire. As mentioned earlier, for triangulation purposes, data was also collected through interviews with engineering staff and documentary analysis of institutional and governmental policy documents (Table 2).

Data collected	Method of collection	Method of analysis
Documents (from both national bodies and the institution)	Selection of relevant documents from the institution's portal, in addition to publicly accessible government policy documents	Documentary analysis
Year 1 & 2 engineering students questionnaire	Online questionnaire	Quantitative analysis Qualitative content analysis
Year 1 & 2 engineering student interviews	Semi-structured verbal questions	Qualitative content analysis
Engineering staff interviews	Semi-structured verbal questions	Qualitative content analysis

Table 2: Summary of methods of data collection and analysis

3.5.1 Online questionnaire.

Although the online questionnaire in this research study was tailored to elicit the reasons for these particular students' decision to study engineering, I was influenced by other research studies which tried to understand why women are under-represented in STEM in other countries (Christie et al, 2017; Kho, 2016; Powell & Boyd, 2012; Wang & Degol, 2017) to formulate this set of questions. These influences will be further detailed in 3.5.1.1.

Overall, the online questionnaire was designed to harvest basic data about the students' family profiles including family links to engineering, their experiences of studying Math at school, their initial perceptions of females and engineering, and their own initial thoughts on the possible reasons for the increase in the number of female students at *the institution* studying engineering. Some of the questions were optional, while others were required, as shown in Table 1. This was related to the type of information that I thought would be essential to informing the subsequent student interviews at the outset of this study. Therefore, questions directed related to these students' or their families' interaction with engineering required a response, while optional questions had the potential to add rich information related to the students' general profile, but were not directly related to these students' interaction with the field of engineering. The final question was required as it was also designed as an

interview recruitment tool, to ascertain if any of the students were willing to take part in a subsequent interview.

As the reasons for the students' decision to study engineering were unknown at the outset of this research, the questions were aligned with potential reasons for female students in other countries to study or not study STEM-related subjects, but particularly engineering. Therefore, the questionnaire and the student responses were also likely to have activated their own personal schemata related to program choice prior to the interviews. In addition, the questionnaire was designed to elicit responses that could be further explored at the interview stage.

3.5.1.1 Online questionnaire design - single items.

The questionnaire's initial questions were designed to be simple, factual and easy for the students to respond to, to draw them into the questionnaire, and maximize the number of questionnaire completions. The first ten questions were factual and straightforward (Table 1) so the students should have had minimal or no difficulty answering them.

Besides question 1, which required a typed answer to the question *How old are you?*, within these first ten questions a built-in menu with either Yes/No or radio button answers was provided for questions 2, 3, 4, 5, 6, 8, and 10. The purpose of this menu was to reduce any burden on the students when responding to the questions, to reduce the possibility of respondent error when answering these questions i.e. to ensure the answers provided were within the spectrum of all potential answers which could be given, and to reduce the potential time taken to complete the survey, ultimately improving the speed with which the students could answer the questions and, therefore, contribute to the overall response rate of the questionnaire. These initial ten questions were also designed to create a mini-profile of each student and to establish whether there had been any familial influences on their decision to study engineering.

As the students progressed through the questionnaire the questions moved from factual, personal questions about themselves to exploring other students and the world around

them. This resulted in the questionnaire being semi-structured, setting the agenda for the questionnaire overall, while not presupposing the students' responses (Cohen et al, 2011d). Therefore, as the students moved through the questionnaire, the questions also became slightly more demanding and the later questions were likely to have required more time and thought on the part of the student when answering them, in contrast with the initial questions. This was intentional as the early questions were designed to warm students up and draw them into answering the questionnaire with easy-to-answer questions, prior to a set of more in-depth ones. While these latter exploratory questions were designed to provide richer data through the students' open-ended responses (Cohen et al, 2011d), the overall design of the questionnaire was to gain maximum responses as, from my personal experiences at *the institution*, I believe that without this gradual increase in intensity there may not have been as many questionnaire completions overall.

Question 11 was designed to learn approximately when these students decided they wanted to study engineering. As it was not significant to learn the specific age at which the students decided to study engineering, along with the likelihood that they would not have been able to precisely identify it, the responses available to students were set out in 5-year intervals, as radio buttons. In broad terms these could be expected to apply to kindergarten (*0-5 years*), primary school (*6-10 years*), early high school (*11-15 years*), and the final years of high school (*16+ years*). This question links to Archer and colleague's (2013) study related to students' identity in relation to engineering, but was also included to identify whether the idea of studying engineering had been part of these students' identity for some time or whether it was a relatively new decision. Depending on the students' responses to this question, family, school, and social media influences could then be explored at interview stage. Question 20 was also designed to explore the possible influence of teachers on their decision to choose to study engineering, as these were indicated to be potential *socializers* in Dick and Rallis' (1991) study.

The options available to the students to respond to in question 12 were based on previous studies in other countries, which sought to understand those female students' choice of HE subject (Christie et al, 2017; Kho, 2016; Powell & Boyd, 2012; Wang & Degol, 2017), along

with anecdotal evidence through informal conversations with engineering staff and others within my institution. These options were provided as ratio buttons and included *family*, *teachers at school*, *future jobs*, *looked interesting*, *I am good at Math and Science-related subjects*, and *other*. This final option allowed students to share additional reasons for them to choose to study engineering, besides the ones already provided. The option *I am good at Math and Science-related subjects* also offered the opportunity for the idea of self-efficacy to be potentially explored at interview stage, depending on students' response to this question.

Question 13 was related to the students' intentions related to future employment. This was important as current literature at the time of writing this thesis suggested that many Emirati female students only chose to study HE to give them time for themselves prior to marriage to reflect on their own identity (Findlow, 2013) or to enjoy the empowerment and freedom which being in HE brings (Alzeer, 2018; Marmenout & Lirio, 2014), especially if their male relatives were opposed to them working. In fact, current literature suggests that it is considered acceptable to Emirati families for their female relatives to study HE as this education takes place in an all-female environment, whereas employment could be deemed as inappropriate for Emirati females (Burden-Leahy, 2009) as they are likely to have to interact with males other than their own family, as mentioned previously. Therefore, this question had the opportunity to provide further insight into these students' future intentions and potentially a link between these intentions and their choice of HE subject. Question 14 was linked to question 13 as it explored whether students had considered employment in the government or private sector upon graduation. This was an important question as it linked to the suggestion that Emirati graduates predominantly seek out public-sector rather than private-sector employment, as referred to in Chapter 2, providing the potential to explore reasons for this at interview stage.

Questions 15 and 16 explored the influence of social media on these students' choices by asking them to provide initial information about their use of social media, which could be further explored at interview stage. Social media options which I believed these students were probably engaged in, based on anecdotal conversations with students of a similar profile at *the*

institution, were *Facebook*, *Whatsapp*, *Twitter*, *Instagram*, and *Snapchat*. Students also had the opportunity to list any other social media they engaged with in an additional ratio button entitled *Other*. This question was included to allow further exploration of the influence of social media on these students' perception of engineering, as Matthews (2013) suggested that a perceived prestige associated with engineering had influenced other Middle Eastern Arab females to choose to study engineering. This question also allowed for the possibility of exploring other potential *socializers* or role models who students may have followed through their social media channels and who may have influenced these students' decision to study engineering if they were either engineers or spoke in positive terms about engineering and/or females in engineering.

Questions 17, 18 and 19 explored the students' self-concept and self-efficacy in relation to Math. According to the students' responses, question 19 also provided the opportunity to investigate whether these students felt that hard work could overcome challenges studying Math, as in East Asian cultures, or whether it was necessary to have a special talent in Math to be academically successful in it, as in other countries like Australia (Marginson et al, 2013). Questions 17 and 18 also investigated Wang and Degol's (2017) suggestion that both an ability and interest are needed for students to choose to study that subject.

Binary responses were required for questions 19 and 22 i.e. Yes/No/Other as I believed that, as these were important areas of data to collect, they should be designed as required responses in the questionnaire. As students could not submit the overall questionnaire without responding to questions 19 and 22, my rationale was to capture responses related to these areas without creating a barrier to the number of completed questionnaires overall. As I could not predict if students would find these questions relatively easy to answer on a scale of 1-10, without having to take time to self-reflect, I was concerned that a scaled response rather than a binary response could have resulted in fewer questionnaires completed overall.

It is worth noting that no questions were included related to the students' parents' educational background nor their families' household income. Although I found no literature to suggest that these would be factors in these students' decision to study engineering at the

outset, I also thought it unlikely that these students would have had knowledge of their families' household income. In addition, it would have been culturally inappropriate to ask these types of questions in this context, so these areas were not explored through the questionnaire.

3.5.1.2 Online questionnaire design - open-ended questions.

The open-ended questions in the online questionnaire were designed to elicit a response from the students without preconceptions and without any set of parameters within which they should answer the question. They were also designed for the students to have the freedom to answer these questions however they chose, without restrictions on word count or sentence structure.

The purpose of questions 21 and 24 were to encourage students to consider whether engineers are different from other professions. They were also designed to explore the potential influence of UAE society on these students' decision to study engineering and, based on the students' responses, to provide the opportunity to explore both these areas further at the interview stage.

Question 23 was directly related to the question of this particular research study and gave students the opportunity share their views on this subject. This question was particularly relevant in informing further interview questions, as it had the capability to provide rich data from the students' perspective on this topic.

3.5.2 Student interviews.

All student interviews were planned to be carried out on an individual basis with only the researcher and the student. However, in two cases, a pair of students wished to be present at the same time and in the same room while each of them was interviewed separately. At the start of each interview, students were reminded that all information they shared was confidential and stored solely with the researcher in a secure safe, as laid out in the participant information sheet (Appendix D) which had been shared with them at the outset of this research. Prior to the interviews being recorded, I sought the students' permission for the

recording to be allowed. All interviews were conducted on campus during breaks between students' classes and over a period of two months, with student interviews conducted prior to staff interviews. The rationale for conducting student interviews first was to gather information from students to be able to later triangulate through staff interviews. Facilitating staff interviews first would likely have rendered less information as I would have had no initial indicators for why these students had chosen to study engineering and no areas to investigate and confirm through the staff interviews. Part of the reason for the length of time taken to carry out the student interviews was the fact that these students had a winter break for nearly one month during the time the interviews were carried out.

3.5.2.1 Design of student interviews.

The first set of interview questions were semi-structured and designed to draw out further information related to the themes in the online questionnaire. Due to the process of multiple reiteration of questions, no pilot as such was carried out. Initial areas of focus for the first interview included whether the students saw engineering as a phase or a commitment, self-efficacy (Bandura et al, 2001; Powell & Boyd, 2012; Rodd et al, 2014), self-concept (Eccles, 2011), the influence of school teachers (Powell & Boyd, 2012) and school, role models, parental (Powell & Boyd, 2012; Skipper & Leman, 2017) or family influence, the influence of social media, the influence of society (Hofstede Insights, 2018; Marginson et al, 2013; Skipper & Leman, 2017), vocational interests (Hübner, Wille, Cambria, Oschatz, Nagengast, & Trautwein, 2017) and patriotism.

As a result of the data collected from the first interview, the next set of interview questions were changed to include information which the students shared which I had not previously considered. Indeed, as each interview was carried out and more data was collected, further ideas emerged from these students, resulting in the interview questions being continually updated and altered to include and focus on these ideas in subsequent interviews. Although the overall areas of focus did not change, the questions within these areas became more refined as the interviews progressed, resulting in five iterations of the interview script being created overall and the final iteration being used the most, at five times (Table 3). The

first and last versions of this interview protocol are presented as Appendix F. The refining of interview protocols was to some extent influenced by grounded theory, which acted as a partial influence in this regard and will be discussed further in section 3.6.2. Refining the interview protocols was necessary as data was analysed from the first interview, which led to a refinement of subsequent interview protocols as some questions were deemed by me to be irrelevant (Corbin & Strauss, 1990). This also meant that the data collection and analysis were interrelated throughout the research study (Corbin & Strauss, 1990). Indeed, as students shared information I had not previously considered, I was then able to update the interview protocol to include questions related to this new information for the next student interview.

Student Interview #	Date of interview	Interview protocol version #
8	21 November	3
12	26 November	3
11	27 November	4
2	28 November	4
29	4 December	5
32	5 December	5
17	6 December	5
21	6 December	5
20	11 December	6
23	11 December	6
1	15 January	7
25	17 January	7
5	24 January	7
37	27 January	7
13	30 January	7

Table 3: Interview protocol versions

These student interviews took between seven and twenty-two minutes, although this does not reflect the amount of data collected as being less from the interviews which were

conducted in less time. Indeed, the student interview which took the least amount of time to conduct was one of the interviews which was conducted in tandem i.e. two students wished to be present in the same interview room at the same time, but each student was interviewed separately. Looking at the richness of the data which was captured in one of the shorter interviews, I can speculate that the second student had time to process the questions being asked of her friend, giving her the chance to consider her answers carefully before taking her turn to be interviewed. Overall, the average time of each student interview was thirteen minutes and they were all conducted in either meeting rooms or classrooms near the engineering block to accommodate ease of access for students. It is worth noting that although the interviews may be perceived as being relatively short, this is only the amount of time in which the interview was captured through the recording device rather than the entire amount of time spent with each student. Prior to each interview, I explained the purpose of the research study, the purpose of the interviews, the value of the student's participation in the interview, and confirmed their consent to take part in the research. I also spent time with the students after their officially-recorded interview was completed and the recording device was switched off, answering their questions related to the study overall which they were more comfortable discussing once the official recording had stopped. This post-interview time was spent informally talking about the value of this research. Therefore, although the captured interviews can be perceived as relatively short, in reality the time spent with the student was longer than the recorded interview time stated.

3.5.2.2 Rationale for one-to-one interviews with students.

Interviews took place with individual students rather than focus groups, to remove the potential for one student to become the group representative and speak on behalf of all other students, as the UAE has a strong collectivist society (Hofstede Insights, 2018). In two cases students asked to be interviewed with another student present (Students # 20 and #23; Students #17 and #21). In both cases I agreed to this to ensure the students felt comfortable taking part in the interview. It is worth noting that although the students arrived in pairs to take part in their interviews, all of these students said they would prefer to be interviewed one-

on-one rather than as a pair of students, which is reflected in the interview transcripts as there is only one set of responses for each of these four interviews.

3.5.3 Engineering staff interviews.

As data was analyzed continuously throughout the data collection process, information collected from both the online questionnaire and student interviews helped to better inform an initial set of questions for engineering staff interviews. These questions focused on similar areas which the student interviews targeted, but also included questions related to *Employment opportunities* and the potential for students to be *Working towards the development of their country*. Engineering staff were also asked to respond to some of the ideas which were formed following an initial analysis of the students' responses, including *Fulfilling a national agenda*, *Emirati families' aspiration for their children to be engineers*, *To secure future employment*, and *Perceived prestige attached to engineering*. Unlike the student interview protocols, which were refined as the student interviews progressed, the same interview protocol was used throughout all three engineering staff interviews as it was evident from the data collected in the first consultative interview with the first engineering staff that this interview protocol was suitable in its first iteration.

Visual graphs were also shown to engineering staff to stimulate and elicit their response in relation to information portrayed in these graphs. This included information highlighting the increased ratio of engineering students compared to the overall student population at *the institution* from 2014 to 2018 (Figure 1) and the majors which were highest in demand in the UAE at this time (UAE Ministry of Education, 2019) (Appendix G). Overall, I hoped to triangulate data collected from the student interviews through the staff interviews. I also hoped to gather additional information related to these staff members' knowledge of the engineering students in general and to gauge their own beliefs for the rise in engineering students at *the institution* in recent years.

The engineering staff interviews took an average of nineteen minutes. As with the student interviews, I also spent time outlining the research study before and after the actual

recorded time, so in reality the time spent with each member of staff was longer than the officially recorded time on the interview transcripts.

3.5.4 Institutional documents.

In addition to the engineering staff interviews, to further triangulate the data collected from students through a second perspective, data was also collected from institutional documents. Some of the information which these documents conveyed included student registration, student programme choice, and overall student population statistics of this institution. Analyzing these documents also served to confirm the rise in engineering student numbers at *the institution* in recent years.

3.5.5 Other documents.

Along with institutional documents, publicly accessible documents were also collected to further support triangulation of data. These documents were published by different UAE government entities and included policy papers related to education and sustainability.

3.6 Data analysis

While the data collected through the online questionnaire's single-item questions were analysed using descriptive statistics, the questionnaire's open-ended questions were analysed using content analysis. Using content analysis in this context, as well as for data collected through the student interviews, provided the flexibility to code and analyze data collected throughout both the quantitative and qualitative stages of this research. This type of analysis was also relevant as it was not dependent on any initial hypothesis, so themes could emerge from the data as it was collected (Cohen et al, 2011e). For data triangulation purposes, content analysis was also used to analyze the engineering staff interviews, while documentary analysis was adopted to analyze documents from the institution (Table 2).

3.6.1 Quantitative data analysis.

Descriptive statistics were used to analyze data collected from the single-item questions in the questionnaire, as this data was predominantly binary or the questionnaire questions

offered students a finite number of options to choose from, rendering this type of analysis most appropriate in this instance (Cohen et al, 2011g). Although these descriptive statistics predominantly took the form of numbers to describe questionnaire data (Cohen et al, 2011g), bar charts and line graphs were also used where it was considered conducive to represent this data visually in the form of graphs. These included students' initial thoughts on their reason for choosing engineering (Figure 5), the types of social media these students use (Figure 6), information related to these students' perceived Math ability at school (Figure 7), and these students' opinions on whether or not a strong Math ability is needed to study Engineering (Figure 8).

3.6.2 Preparing the qualitative data for analysis.

All interviews were transcribed within a few days of them taking place. In almost all instances, each student interview provided further insight into the reasons for their decision to study engineering. Therefore, as categories and themes began to emerge from these student interviews, interview questions could be tailored further to draw out information related to these areas. An initial set of thirty-one categories was identified by manually coding the student interviews (Appendix E). Once these initial categories were established they were used to create nodes using NVivo software. As the student interviews were uploaded into NVivo and nodes were assigned to these interviews using the initial set of broad categories, these could then be refined. Equally, as the data was organized into sets of these categories, it became apparent that some of these themes could be further merged in some instances, but divided into further sub-themes in others.

Although grounded theory was originally considered for this research study and then excluded as case study was deemed to be a more appropriate approach in this instance, grounded theory acted as an inspiration for the data analysis in this study. As there is little literature about this particular topic in the UAE and particularly in Dubai, as mentioned earlier, the idea of emergent themes and inductive analyses which are present in grounded theory (Cohen et al, 2011f) resonated in this context. Indeed, as with a grounded theory approach, the data analysis in this study was an ongoing process throughout the research rather than a

separate phase at the end (Goulding, 1999). Furthermore, the inductive, progressive nature of grounded theory influenced the modification and honing of the student interview protocols to gain richer data from the students as the interviews progressed and they shared information that I had not previously considered. Overall, although grounded theory was inspirational for some elements of this research study, it is important to note that data was not collected using the grounded theory procedure of *theoretical sampling*, nor was the *constant comparative method* of data analysis (Merriam & Tisdell, 2016) undertaken in this research study as it would have been in a purely grounded theory study. This is also important to point out as Corbin and Strauss (1990) have stressed that merely including some grounded theory procedures in a study does not make it a grounded theory study.

3.6.3 Qualitative data analysis.

The data collected through the online questionnaire's open-ended questions was analysed using content analysis. Using content analysis in this instance, along with the data collected through the student interviews, allowed the data to be coded, categorized and compared before arriving at a set of conclusions (Cohen et al, 2011e). Using this type of analysis also aligned with the fact that it was not possible to accurately predict these students' descriptions of engineers, their reasons for choosing engineering, nor their opinion of other students' rationale for choosing to study engineering. As a result there were no initial hypotheses to be proved or disproved.

Nevertheless, while this research was not guided by a set of hypotheses, theory did influence some of the stages of this research study including the questionnaire protocol and subsequent interviews. Indeed, the initial areas which were chosen to be further explored with the students in this research study were based on documented reasons for other female students to have chosen to study STEM-related subjects in other settings around the world, as discussed earlier.

However, it is also worth noting that although my initial interview protocol was guided by this theory, new categories emerged which were not in previous literature as little research has been carried out on this topic before, as also mentioned earlier. Instead, themes emerged

from the students' responses with data analysis being an ongoing process, running simultaneously alongside the data collection process (Merriam & Tisdell, 2016), and continuing until no new themes emerged and a saturation of ideas had been reached.

The data was initially analyzed manually and organized in table form for both the online questionnaire's open-ended question responses (Appendix H) and the student interviews, which were organized by theme (Appendix E). Subsequently, due to the density of the data collected through the student interviews, the interview transcripts were uploaded into NVivo 12 Pro software (Appendix J) where nodes were created according to the original themes. As the nodes developed throughout each interview, it became apparent that some of these ideas were similar and could be merged together, while others were sub-nodes of a single idea. Using the NVivo naming convention, primary nodes were classified as parent nodes and sub-nodes were classified as child nodes. For example, *Engineering role models* was categorized as a parent node (Appendix K), with child nodes of this parent node being *Female engineering role models in family*, *Female engineering role models outside of family*, *Male engineering role models in family*, and *Male engineering role models outside of family* (Appendix L). The process of organizing these parent and child nodes through assignment and merging continued until no further categories nor subcategories emerged from the collected data (Table 4). Although NVivo organizes nodes alphabetically, rather than by any other criteria, I felt it more appropriate to order the nodes by significance to this study. Therefore, numbers were added to the parent node names. As the number 10 fits after the number 1 sequentially, parent node 10 was assigned the number 99 to ensure it followed parent node 9 (Appendix M).

Parent Node	Child Node
1 Family	• Aspiration for family member to study engineering • Family support
2 A sense of self-worth	• Chose major perceived to be the hardest • Desire to be unique or special • Prestige attached to engineering
3 Engineering role models	• Female engineering role models in family • Female engineering role models outside of family • Male engineering role models in family • Male engineering role models outside of family
4 Securing their future	• Desire to work in government sector • Good salary • Future employment opportunities
5 Fulfilling a national agenda	• Contribute to their country (UAE) • Need for engineers in the UAE • Need for Emirati females to join the workforce
6 Influence of school	• HE exhibition visit • High School curriculum designed to encourage students into STEM • Increased Math in school prepares for college • School teachers' encouragement
7 Gender equality	*No child nodes present*
8 Interested in Math and/or Physics	*No child nodes present*
9 Perseverance to achieve academic success	*No child nodes present*
99 Following a trend to study Engineering	*No child nodes present*

Table 4: Categories assigned through NVivo

3.6.4 Documentary analysis.

To further improve the density of the data and to strengthen data triangulation in this research study, particularly as the data was being collected from different approaches and with different techniques, institutional documents available through *the institution's* portal and publicly accessible government documents were also analysed using documentary analysis.

As the institutional documents were designed to provide figures and statistics related to students at this campus, it was appropriate to convert this information into graphs to more

clearly illustrate the information gathered through these documents. This was particularly applicable when illustrating the statistics of the student population at this campus over several years (Figure 1). Information from the publicly-available government documents were interwoven into the literature review in Chapter 2, as well as the overall findings of this research study in Chapter 5.

3.7 Ethical considerations

3.7.1 Informed consent.

Once ethics approval was granted both locally by *the institution* and also through the University of Liverpool's Virtual Programme Ethics Committee (Appendix A), I visited all Year 1 and 2 engineering student classes. In these visits information was shared about this research study, students' questions were answered, and an information sheet was disseminated to all students to inform them about the research study (Appendix D). One side of the information sheet was in English and the other in Arabic, to ensure all students were fully aware of all aspects of the study. Classes were subsequently visited again for consent forms to be disseminated in both English and Arabic to students who were interested in taking part in the research study (Appendix C). In this subsequent visit, students were once again reminded that all information shared throughout this research study was confidential and would be stored in a secure location with the researcher only. Students were also reminded that they could change their mind about participating in the study at any time, without any negative consequences to them (Bengtsson, 2016).

In the case of faculty, an information sheet was also distributed to all engineering faculty to ensure they were fully aware of the details of the research study (Appendix B) when they were invited by email to take part in an individual interview. Prior to the interviews being conducted, faculty were asked to complete a consent form (Appendix C) and verbally reminded that they could leave the research study at any time, without any negative consequences to them.

3.7.2 Confidentiality.

Although confidentiality is important in any research (Cohen et al, 2011h), in this instance confidentiality was particularly important as a lack of it in this setting with these students could have resulted in significant cultural issues due to UAE traditions. Although in other situations anonymity has the potential to solve issues of confidentiality, it was not possible in this case as I interviewed the students in person and already knew some of these students by sight. In addition, as mentioned earlier, the online questionnaire was disseminated using the institutionally-licensed Microsoft Forms which is designed to capture email addresses and identities electronically, so anonymity would not have been completely possible. Furthermore, I was also aware of the identities of the engineering staff who were interviewed.

Therefore, to ensure confidentiality was maintained throughout the research study, a form of numerical coding was used to refer to all research participants, both students and faculty. In addition, if students or faculty mentioned their names during the interview their name was not transcribed, but instead the words *name of student/faculty* was entered in place of their name. Furthermore, prior to their interviews, all participants were reassured that they were not obliged to answer any questions they believed to be inappropriate (Oliver, 2003).

3.8 Summary

In summary, an explanatory sequential mixed methods approach was used to carry out a case study exploring the reasons for a group of students' decision to choose to study engineering at *the institution*. This was undertaken through an initial online questionnaire, followed by a set of semi-structured interviews with some of the questionnaire respondents who agreed to take part in these interviews. Data was continuously analyzed throughout the research study, with each element subsequently informing the next. Data triangulation was ensured through a set of semi-structured interviews with engineering staff at this campus, along with an analysis of institutional and publicly accessible government documents.

To ensure this research was undertaken ethically, formal ethics approval was granted by both *the institution* and the University of Liverpool prior to any data being collected. All

research participants were informed of the purpose of this research study through detailed information sheets. In addition, participants were asked to complete consent forms prior to their involvement in this research study, but were equally informed that they could withdraw from this research at any time without any negative consequences to them.

Chapter 4: Findings and Analysis

4.0 Introduction

Of the 152 engineering students who were invited to take part in the online questionnaire, forty students responded. As mentioned previously, some questions in the online questionnaire were mandatory, while others were optional (Table 1). Analysis of the data collected through the online questionnaire was carried out using quantitative analysis for the single-item questions and qualitative content analysis for the open-ended questions. Qualitative content analysis was also adopted for the student and staff interviews, as described in Chapter 3 (Table 2).

4.1 Online questionnaire - data analysis

4.1.1 Online questionnaire - single-item questions.

4.1.1.1 Personal information and family.

Looking at the data collected through the online questionnaire, 95% of the students who responded were aged between 18 and 20 years old (Figure 2). Only one student was 21 years old and another was 23 years old (Figure 2). All of the students had siblings, but two had only sisters i.e. no brothers and two had only brothers i.e. no sisters.

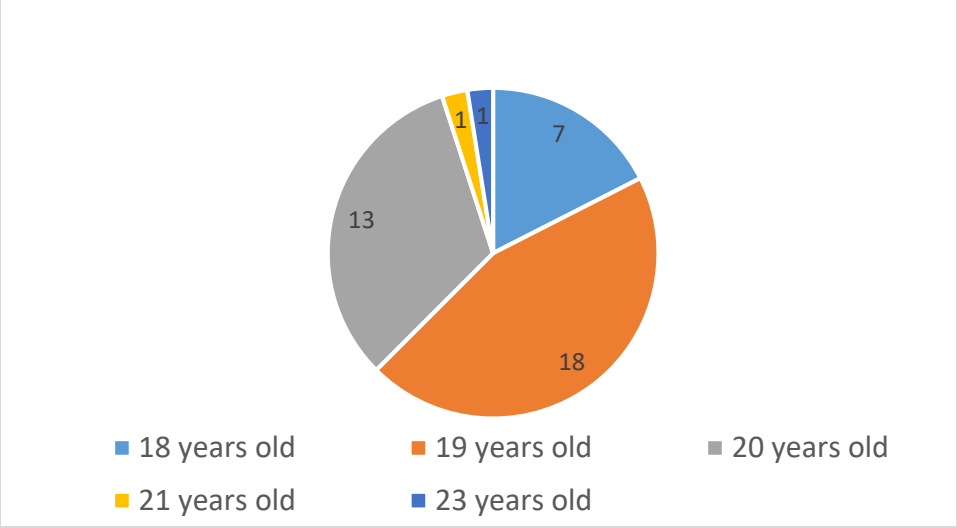

Figure 2: Age of students (n=40)

40% of the students' mothers worked (Figure 3). Although 42.5% of the students shared the specifics of their mothers' current or previous jobs i.e. before retirement, none of these jobs were related to the field of engineering. 12.5% of the students' mother were retired (Figure 3), of which two students shared that their mothers had been teachers prior to retirement. 47.5% of the students' mothers were not employed at the time of this research study (Figure 3).

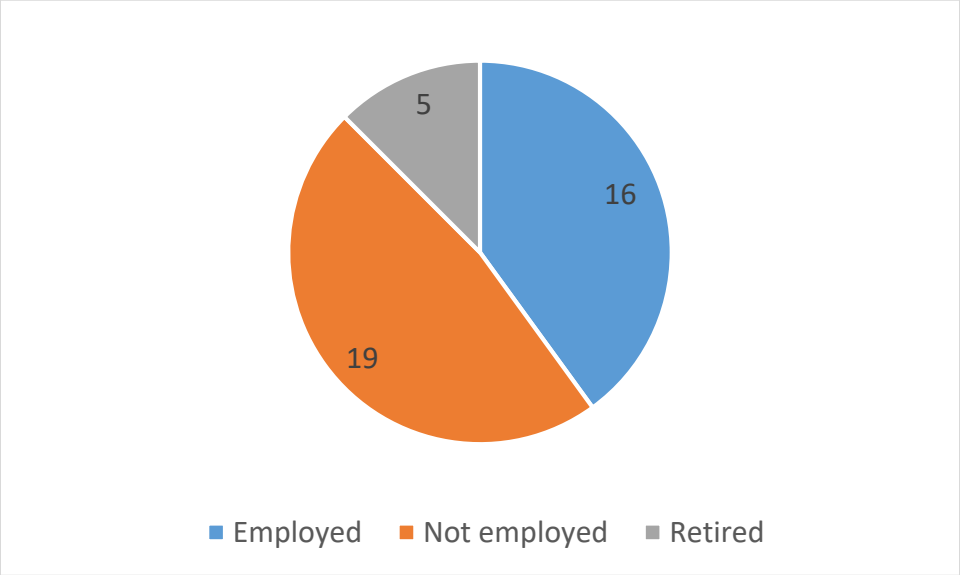

Figure 3: Employment status of students' mothers (n=40)

62.5% of the students' fathers were working at the time of this research study (Figure 4). Only one student explicitly stated that her father worked as an engineer, but a third of the working fathers had professions which could have included elements of engineering, with one father working for the Dubai Water and Electricity Authority (DEWA) and eight employed by the military. Almost a third of the students' fathers were retired and 10% of the students' fathers were not employed at the time of this research (Figure 4).

Given the fact that UAE federal law related to retirement and pensions states that Emiratis can retire from the age of 49 or after serving a minimum of twenty years service, it is not surprising that many of these students' parents were retired (Government.ae, 2019f).

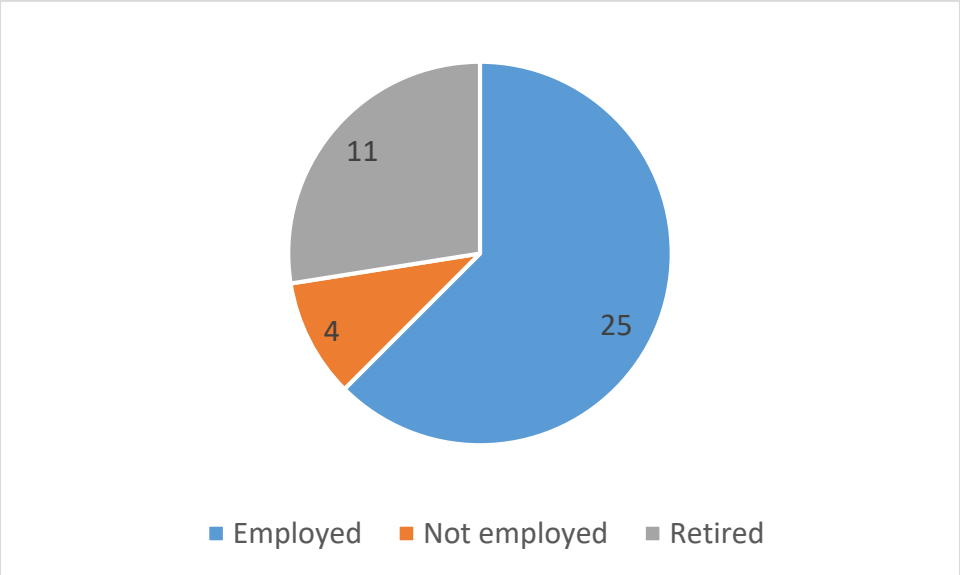

Figure 4: Employment status of students' fathers (n=40)

More than half of the students' parents worked in the government sector. Of the students' mothers who worked, just over half were employed in the government sector, at 56%, while the same was true for 68% of the students' fathers.

Exactly half of the students had someone in their family studying engineering, while 57.5% of the students had someone from their family working in engineering at the time of this research.

4.1.1.2 Choosing engineering.

The results of the questionnaire showed that these students were aware they wanted to study engineering from adolescence, with 82.5% of them deciding at 16 years or older and 17.5% deciding between the ages of 11 and 15 years of age.

Their predominant reason to choose engineering as a course of study was for *Future jobs*, with 65% of the students selecting this option (Figure 5). This was followed by *I'm good at Math and Science-related subjects*, selected by 52.5% of the students, and *Looked interesting*, selected by 47.5% of the students. Following this, a quarter of the students chose *Family* as a reason and only one student cited *Teachers at school* as a reason. Additional comments related to *Other* included "Because it's something new" (Student #16, Appendix I), "To be unique"

(Student #39, Appendix I), "Wanted to study something different since my family is in law forces" (Student #37, Appendix I), "New things make me interested" (Student #30, Appendix I), and "To function my abilities to serve my country" (Student #1, Appendix I). Finally, one student commented: "Honestly, I've no idea" (Student #10, Appendix I).

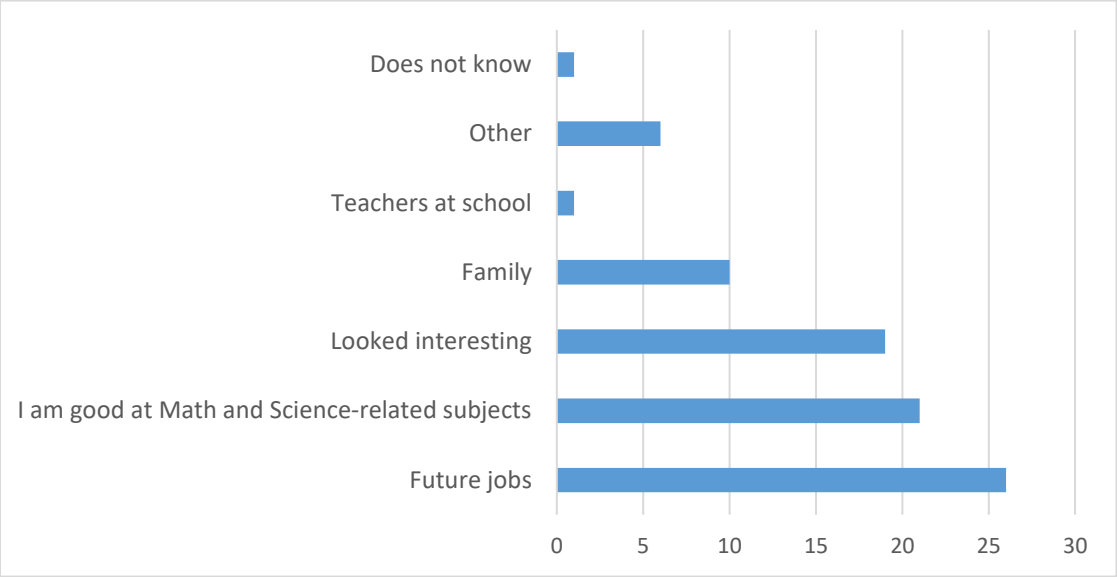

Figure 5: Why did you choose Engineering at college? (n=40)

Of the total students, 80% of them planned to work as an engineer, 17.5% were still unsure, and only one student did not plan to work as an engineer in the future. Of the 80% of students who did plan to work as engineers, just under half of them planned to work in the government sector rather than the private sector at 46.8%, with another 46.8% of this group of students unsure of whether they would like to work in the government or private sector. Only 3% of the students who planned to work after graduation stated that they would prefer to work in the private sector. This sentiment was also reflected in the responses of the students who were unsure if they would work in engineering in the future or not as just over half of them stated they would prefer to work in the government sector too and none of them stated that they would prefer to work in the private sector.

4.1.1.3 External influences.

All of the forty students stated that they were engaged with social media. Instagram was the most prevalent with 95% of students using this, followed closely by Whatsapp used by 90% of students, and Snapchat used by 87.5% of students (Figure 6). Twitter was less predominant with only 52.5% of all students using it. In addition to these social media applications, 7.5% of students also used Facebook, Kakao Talk, and Telegram.

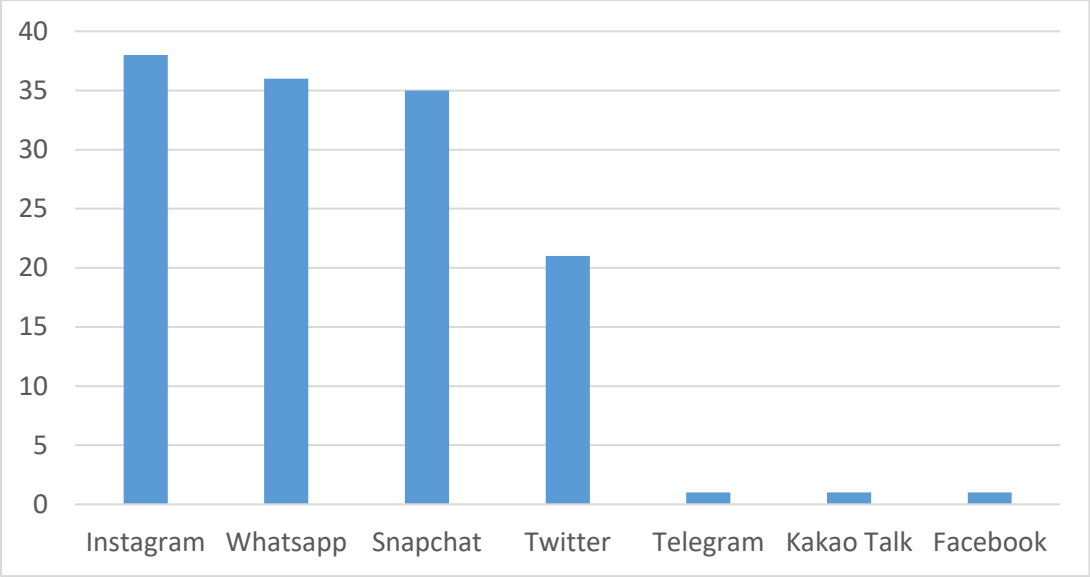

Figure 6: Use of social media (n=40)

Almost all of the students who participated in this study enjoyed Math at school, with 55% of students stating that their Math ability was *Very good* and 40% of students sharing that it was *Quite good* (Figure 7). Of the three students who did not enjoy Math at school, two felt their Math ability was *Not good*. 87.5% of the students believed that good Math was required for engineering, while only 7.5% of students were unsure if this was necessary (Figure 8).

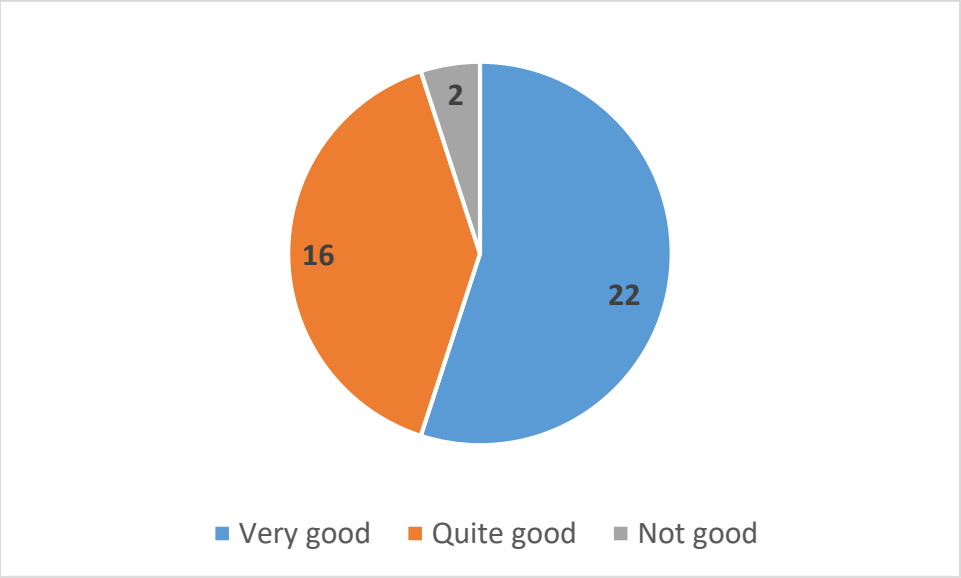

Figure 7: How was your Math ability at school? (n=40)

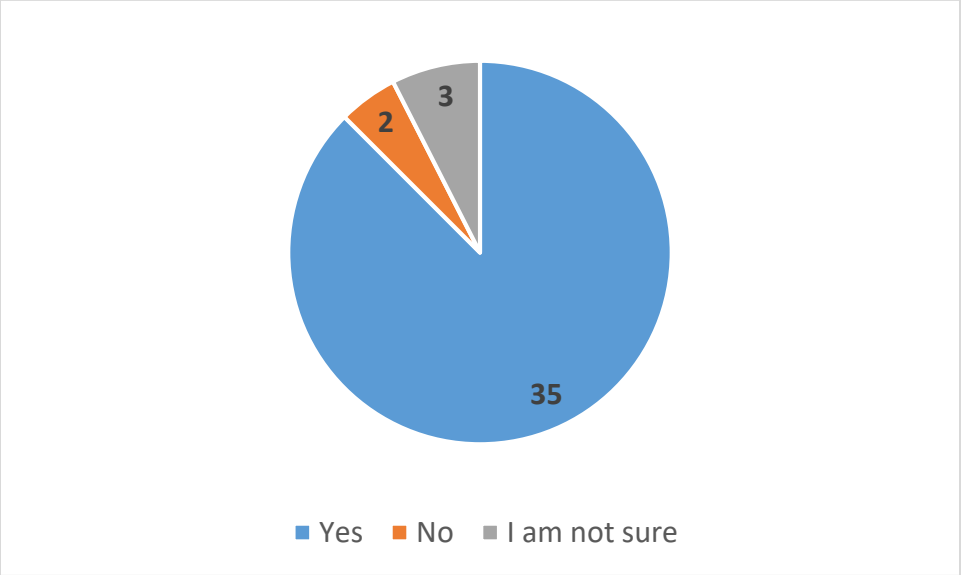

Figure 8: Do you think you need good Math to study Engineering? (n=40)

Looking at the potential influence of teachers, 65% of these students stated that no teacher ever encouraged them to study engineering at college, 32.5% of students shared that a High School teacher had encouraged them, while one student shared that their "aviation teacher" had specifically encouraged them to study this programme.

4.1.1.4 Influence of society.

To the question *Do you think engineering is a job that all women can do?*, 52.5% of students believed it was, while 45% of students chose the response *It depends*. Only one student stated it was not a job that all women could do.

4.1.2 Online questionnaire - open-ended questions.

4.1.2.1 Students' perception of engineers.

62.5% of the total questionnaire respondents answered the open-ended question *How would you describe engineers? Are they different than any other profession?* which explored how these students visualized engineers. Of these respondents, a third responded specifically to the second part of the question stating that engineers are different from other professions.

Overall, comments related to the perceived characteristics of engineers showed the fact that these students viewed them in largely positive terms such as:

- ambitious: "ambitious" (Student #20, Appendix H)
- creative: "we have creativity" (Student #23, Appendix H)
- good with their hands: "like to use [their] hand[s]" (Student #17, Appendix H)
- hard-working: "hard workers" (Student #1); "hard workers" (Student #21, Appendix H); "work hard" (Student #22, Appendix H); "[engineering] needs effort" (Student #28, Appendix H).
- in possession of good time management skills: "time management…multiple tasks as the same time" (Student #1, Appendix H) and "able to manage…time" (Student #39, Appendix H).
- intelligent: "they have intelligence" (Student #7, Appendix H), "engineers are so smart" (Student #9, Appendix H).

Engineers were also described by the students in relatively pragmatic terms, as they were described as having an ability to:

- Focus and concentrate: "focused and concentration" (Student #18, Appendix H), which may also be linked to Student #21 who stated that "they are doing their best to achieve their goals" (Appendix H).
- Prioritize: "determining priority" (Student #1, Appendix H)
- Solve problems: "capable of solving things" (Student #8, Appendix H); people who "find the smartest way to work out things" (Student #35, Appendix H); people who "are able to apply [their] studies" (Student #37, Appendix H).
- Think analytically: "analytical thinking" (Student #1, Appendix H); "this ability [to] think reasonably about problems and solutions" (Student #35, Appendix H)
- Use technology: "more with technology development" (Student #34, Appendix H)
- Work under pressure: "work under pressure in multiple tasks" (Student #1, Appendix H)

4.1.2.2 Students perception of why other students are choosing engineering.

Slightly more students responded to the open-ended question *Why do you think that more and more students at your college are choosing to study engineering?* with 72.5% of students sharing their thoughts on this.

The overwhelming opinion of the students who responded to this question was that more students had chosen to study engineering due to potential employment opportunities available upon graduation. This was referred to by Students #1, #11, #16 and #37 who felt that there were no more jobs available in the other majors (Appendix H). Meanwhile, further data which supported the belief that students had more job opportunities by graduating from engineering was evident through comments such as "future job" (Student #3, Appendix H), "job opportunities available" (Student #8, Appendix H), "because of the future jobs" (Student #9, Appendix H), "for future jobs" (Student #17, Appendix H), "the main reason is the job" (Student #22, Appendix H), "for work" (Student #23, Appendix H), "to have a better jobs" (Student #27, Appendix H), "the engineer can work in several fields" (Student #28, Appendix H), "job opportunities" (Student #32, Appendix H), and "engineering jobs are highly demanded" (Student #35, Appendix H). Similarly, Students #13 and #21 referred indirectly to more

employment opportunities being available to engineering graduates through their comments that the UAE needs more engineers (Appendix H).

The idea of current engineering students securing their future may also be linked to the idea of future jobs, as Student #2 shared that engineering is chosen by students "to have a good future". Additional students commented that engineering is "the future" (Student #14, Appendix H), "plays an important role in today's life and future" (Student #21, Appendix H), is a "good future" (Student #26, Appendix H), "has a bright future" (Student #32, Appendix H), is "helpful for the future" (Student #34, Appendix H), "has a better future" (Student #38, Appendix H), and that students choose engineering as "it's good for their future" (Student #39, Appendix H). Student #28 also commented that "engineering has a future more than other major" and Student #40 shared that students "chose engineering just so their future can be 'secured' and 'safe'" (Appendix H).

This idea of securing their future could also be linked to the students' belief that graduating from engineering would result in a more lucrative salary, which in turn ensures further financial independence. Students shared that the engineering "wage is extraordinary" (Student #11, Appendix H), that students had chosen engineering "because it has a…high salary" (Student #32, Appendix H) and "because of the salary" (Student #35, Appendix H).

Hand in hand with a high salary was also the idea that engineering had a perceived prestige. This was evident through Student #1's comments that "being an engineer is something really high class" (Appendix H), in addition to the suggestions that students only chose engineering "to graduate as an engineer" (Student #15, Appendix H), for the title of Engineer (Student #25, Appendix H) or "for show" (Student #36, Appendix H).

One student suggested that engineering was being chosen as it is a more challenging major than programmes such as Business, which she believed everyone could study (Student #39, Appendix H), leading to too many graduates in these fields. This idea may also have been echoed by Student #4 who commented that engineering was a "new major for women students". However, this idea was contradicted by Student #16 who suggested that this particular institution provided foundation courses in engineering to support students with the

basics of engineering, unlike other institutions (Appendix H), which meant that the engineering programme was in fact accessible by all students regardless of their previous educational background or ability. In addition, another student shared the fact that *the institution* offers a variety of options to be able to study in engineering (Student #21, Appendix H).

One student suggested that students were choosing to study engineering due to their parents' aspirations for them to be engineers (Student #40, Appendix H). The same student also suggested that students may have always wanted to be an engineer since they were a child (Student #40, Appendix H), although this could also be seen as related to parental influence on these students in their formative years.

Pragmatic reasons were also suggested as a reason for students to choose engineering (Student #23, Appendix H) as well as the belief that they are being better prepared for this subject at school (Student #35, Appendix H).

One student also suggested that more students at this campus were choosing to study engineering as "female engineers are becoming better than men" (Student #11, Appendix H).

Of the 62.5% of students who added these additional comments in response to the open-ended questions of the online questionnaire, just under half of these students were part of the fifteen students who volunteered to take part in a further interview where their responses could be explored further.

4.2 Qualitative data analysis

The qualitative data in this research study was captured through interviews with fifteen Year 1 and 2 engineering students, along with three engineering division staff. As discussed earlier in chapter 3, each interview was carried out individually, apart from student interviews #17 and #21 who were interviewed individually, but alongside each other, at their request. This was also the case with student interviews #20 and #23. All staff interviews were conducted individually.

4.2.1 Analyzing the qualitative data.

Overall, it is worth noting at this point that the engineering staff who were interviewed confirmed that there had been a significant rise in the number of engineering students at *the institution* in recent years. Although Staff #1 believed that this rise had now "reached a steady state" (line 28), they linked this to the overall general decline of students choosing to study at this institution (Figure 1).

Looking at the data collected through the semi-structured interviews with students, the initial influences which emerged as reasons for these students to choose to study engineering are discussed in this section. As the rationale for interviewing engineering staff was for data triangulation purposes, staff responses are interwoven into the students' responses to support the analysis overall.

4.2.1.1 Family.

The influence and effect of family appeared throughout all of the student interviews, either as a result of direct questions posed to the students about their family or indirectly as students shared information. Although family influence was dominant throughout the interviews, the level of support and/or guidance offered to these students varied.

4.2.1.1.1 Aspiration for family member to study engineering.

One area of familial influence appeared to have been related to the aspirational title of *Engineer*, with a third of the students' families aspiring to this (Student #8, Student #20, Student #23, Student #25, Student #32). In these cases, families appear to have encouraged their female relatives to study engineering due to the perceived prestige associated with being an engineer within UAE society:

> "They always had high hopes for me…When I told them I want to be an…an engineer they were up for it, because they, eh, always thought I was gonna be something big so…they were really supportive of me." (Student #8, line 20)

"…they were so proud of me because I'm the only one in my small family, I want to be an engineer…" (Student #25, line 82)

"…my mother and my father they always want me to be an engineer…because it's a high position here in UAE…" (Student #32, line 8)

Indeed, two students had a preference to study a completely different major (Student #20, Student #23), but one or more members of their family overruled this idea in favour of them studying engineering instead:

"…my parents, they preferred if I…if I studied engineering and I was good in Math and Physics, so…I chose Engineering instead of Law." (Student #20, line 22)

A similar situation occurred with Student #23 who originally wanted to study "interior design" (line 10), but her father advised her that there were no opportunities in this field and encouraged her into engineering instead.

Staff #1 also believed that having engineering parents could have been one of the factors in students' choice of engineering:

"Actually, I found some students…it turned out that their parents are engineers… So…probably they encouraged their children to be engineers as well." (Staff #1, lines 50-52)

4.2.1.1.2 Family support.

Besides influencing their female relatives to study engineering due to the prestige of this position or because their parents are engineers, 86% of the students felt supported to study in HE due to their family members' general encouragement:

"…the big support that I got was from my father." (Student #1, line 46)

"I asked them about the programme and the…so that…they encouraged me also." (Student #2, line 74)

"He encouraged me." (Student #5, line 80)

Indeed, this support was not just linked to the studying of engineering, but extended to any tertiary level programme their female relatives hoped to study:

> "My family just were happy for me. They said any choice you would like to make it's your career path, you need to know what you want." (Student #11, line 36)

> "They were, like, it's OK…like, it's your decision, you can enter whatever you want, but…it's your responsibility. Whenever something happens, it's your responsibility. So, you must depend on yourself." (Student #21, line 70)

Nevertheless, this level of support was not equal across all families. In some cases these students' mothers were supportive, while their fathers were apprehensive about the decision (Student #17). One student recognized that her family were "not that open-minded", but that they were still "supportive" of her decisions in general (Student #37, line 20). She commented that this was particularly true of her mother and suggested this was probably due to the fact that she worked with men as a "police officer" (Student #37, line 22), so had a broader understanding of the UAE workplace.

Overall, this level of family support seemed normal to these students, to the extent that some students seemed surprised at the question of whether their family were supportive of their decision or not (Student #13; Student #29).

Although most students shared their experience of family support, Student #12 commented on her family's indifference to her studies:

> "I think like my family don't know what I am studying now." (Student #12, line 72)

She maintained that this was probably due to the fact that she was the youngest in her family and all her siblings had their own families to be concerned with now:

> "…they have their own, own family, and so they are, don't look after me." (Student #12, line 74)

4.2.1.2 A sense of self-worth.

Throughout the interviews, a fifth of the students indicated that studying engineering contributed to their sense of self-worth as they were able to contribute to their country (Student #8, Student 11, Student #25, Student #29, Student #37). This took the form of a desire to be different, unique or special and was usually connected with a future contribution they could make towards the development of the UAE.

4.2.1.2.1 Desire to be unique or special.

One idea that appeared throughout some of the interviews was a desire to be unique or special. Student #1 shared that she had chosen to study engineering as it was "something really new" (line 68) for Emirati females to study. This was echoed by Student #37 who said that she chose engineering as she "wanted to study something that not a lot of students would pick…or people would think of" (line 130). In some situations this desire to be unique extended to an ambition to be the first engineer in their family (Student #12).

One of the students shared that being an engineer would enable her to realize her dream to be the first Emirati to build something "beautiful in the UAE" (Student #25, line 70). She hoped this project would not only stand out in the UAE, but also "in the whole world" (line 72) and this was the driving force behind her persistence in studying engineering, even when she found her studies challenging.

Another student suggested that Emirati males were lacking in ambition compared to her and other Emirati females:

> "…they don't…don't want to be in high. Y'know? It's ok for them any job…anything…any study. But for me, no…I want to be something in the future." (Student #29, line 52)

She believed that this sense of determination amongst Emirati females had contributed to the rise in numbers studying engineering compared to Emirati males who found it too challenging and that she wanted to contribute to her country and have her name associated positively with the UAE (Student #29).

4.2.1.2.2 Prestige attached to engineering.

Consistent with the idea mentioned earlier that some of these students' parents perceived engineering to have a certain prestige attached to it within UAE society, the same idea was echoed by just over a quarter of the students. These students believed it was possible that other students had chosen to study engineering at this campus for either the perceived prestigious title of *Engineer* (Student #1; Student #5; Student #29) or even for the lab coats worn by engineering students at this campus (Student #17), which singles them out as different from other divisions.

In addition to this, some students also shared their own belief of the prestige of engineering (Student #8; Student #32; Student #37), with one student sharing that if she achieved the qualification of engineer she was going to "brag about…to all the people" (Student #11, line 58). Similarly, Student #32 shared that she aspired to be an engineer "because it's a high position" within the country and that she would be proud to have her name associated with the title of *Engineer* (line 8).

The idea of engineering having prestige attached to it in the UAE was also confirmed by two of the engineering staff:

> "I would say in the Eastern or Middle Eastern culture, whether that's here in the Middle East or India or something or the Arab countries…OK, being a doctor or an engineer is a prestigious thing…" (Staff #1, line 124)

> "Engineering eh, y'know…Middle East, Gulf countries it is really a big thing, right?... the E.N.G. before your name is a really big thing." (Staff #3, lines 52-56)

4.2.1.2.3 Chose major perceived to be the hardest.

Two students stated that they had chosen to study engineering as it was perceived to be the most challenging major to undertake:

> "…we had everything, but I just set my mind on the top (laughs). I always go for the big catch, that's how I do it." (Student #11, line 24)

> "But I want to study something hard. Anywhere you go, which one, which Engineering is the difficult, they will say Electrical Engineering. That's why I'm studying Electrical because this is difficult." (Student #29, line 80)

Meanwhile Student #21 said that when she graduated she would be able to reflect back on having had the "self-confidence" to enter engineering (line 74), which suggested that this characteristic was needed to undertake a major which was perceived to be so challenging. This aligns with Staff #1's comments mentioned in Chapter 3, confirming the difficulty of engineering compared to other majors at this campus. Indeed, Staff #2 also shared their experience that more than half of their students usually failed the basic Math and Physics assessments, but that this was considered to be typical as, in their experience at *the institution*, these subjects were a challenge for these students. Staff #2 commented that these failures then resulted in students having to repeat these courses to enable them to progress through the programme and that sometimes this happened multiple times. Indeed, more than half of these students shared their belief that studying engineering was a challenge:

> "It's…it's…harder than I expected actually. It's really hard." (Student #8, line 4)

> "…I didn't take the courses…eh…like now, so it was for me difficult at the beginning" (Student #17, line 20)

> "…it's a challenging major…" (Student #20, line 132)

> "…it's a very hard subject…a hard course" (Student #21, line 24)

> "I know it's difficult, but I don't know if I can complete on it or no because it's difficult I really…it's not easy." (Student #32, line 80)

In some cases, students confided that although engineering was not a challenging subject for them, it was nevertheless a challenging subject for other students:

> "…not that many girls are capable of keeping up with the Math and the Physics." (Student #8, line 54)

> "I know some people, like, it's really so difficult for them. They really want Engineering but they can't pass in it. Like…eh, they don't know anything about Math." (Student #13, line 88)

> "but my friends, eh…those who was in Arts section, they, they cannot do assessment Engineering because it's…it's a bit, eh, hard for them, they know…they don't know the basics, formulas, and that's it." (Student #25, line 28)

There was also a belief that it was necessary to "have good Math and Physics" (Student #5, line 184) to succeed in this programme:

> "…it needs a lot of focus and you need to be <u>really</u> good in Math." (Student #11, line 8)

In addition to being a challenging subject, one student also added that she regretted joining the Engineering programme as she had discovered that "it's not only hard. It's not fun." (Student #13, Line 10).

4.2.1.3 Engineering role models.

Besides the influence of direct family members, the idea of male and female engineering role models both inside and outside their family was explored during the student interviews to see if this may have had an impact on some of these students' decision to study engineering.

4.2.1.3.1 Female engineering role models in family.

Of the female engineering role models in these students' families, only two were in the students' immediate families. Student #13's mother was an engineer connected with interior design, while Student #1's sister was studying in engineering, but in another institution. Other female relatives included a niece (Student #1), an aunt (Student #5), and cousins (Student #2; Student #20; Student #25).

However, although these students' female relatives were either studying or working in the engineering sector, only Students #2 and #25 specifically stated that their female relatives were a direct source of inspiration for them to choose to study engineering. In fact, one

student whose aunt was an engineer and whose mother worked in an engineering environment emphatically stated that her family were supportive of her decision to enter the engineering programme, but that having females in an engineering position was not an influence on her decision to study engineering:

"No. It had no…(laughs)…It's my own choice." (Student #5, lines 114-116)

In these cases it may be possible that having female relatives already in the engineering sector was not a direct influence on the students themselves, but rather an influence on their parents to encourage them to study engineering. This is potentially illustrated by the fact that Student #20 had two female cousins who were engineers, but this did not influence her away from her original desire to study Law. Indeed, it was her parents who dissuaded her from studying Law to study engineering instead, as mentioned earlier. Therefore while it may be possible that the students' parents were potentially influenced by the fact that other female relatives were already in the engineering sector, any influence on these students' parents is outside the scope of this particular research study.

4.2.1.3.2 Female engineering role models outside of family.

Again, female engineering role models outside of these students' families were mentioned, but largely not in the context of being a direct influence on their study path into engineering.

When prompted to think of any Emirati females in engineering, Student #23 remembered a prominent Emirati female engineer who visited her High School to share her experiences of being one of the first female engineers in the UAE. However, the main point of interest for this student appeared to be that this woman was also a make-up artist which had been challenging for her family to accept, as she had flown to the UK to qualify in this career.

Student #5 also said she was aware of a famous Emirati female engineer. Although she initially did not "know the name" (line 134), later she remembered it and that this woman was the first female engineer in the UAE.

The exception to this was Student #8 who shared that she was specifically influenced to study engineering when she was a teenager as a direct result of seeing a group of young women on television promoting a STEM-related project they were working on:

> "Oh! Yes. I was watching TV…so there was some girls that really inspired me… Eh, so, when I saw that I don't know, something in me clicked that I wanted to be that. I wanted to do something and make a difference." (Student #8, line 12)

Another student had been following aircraft engineers on Instagram since High School as she hoped to study Aviation Engineering, even though this option was not available to her at *the institution* (Student #12).

In some cases these female role models appear to have been identified once the students were already in the engineering programme (Student #17).

4.2.1.3.3 Male engineering role models in family.

Compared to female engineering role models, there were considerably more potential male engineering role models in these students' families, with two-thirds of the students sharing the fact that male members of their family were in the engineering sector. These family members included brothers (Student #1; Student #5; Student #8; Student #11; Student #23; Student #29), uncles (Student #5; Student #8; Student #12; Student #17) and cousins (Student #25; Student #32). One student shared that three generations of her family had been associated with the field of engineering – her brother, father and grandfather (Student #29).

However, despite this abundance of potential male engineering role models, it seemed that only one student was directly influenced to choose engineering as a result of seeing her older brother studying this discipline:

> "…'cos my brother was an engineer, so I looked up for him…so…that's why I picked…picked. I also picked Engineering because I looked up at him…" (Student #8, line 16)

4.2.1.3.4 Male engineering role models outside of family.

Only Student #12 commented directly on a potential male engineering role model outside her family. She followed both male and female aircraft engineers on Instagram, as mentioned earlier.

4.2.1.4 Influence of school.

There was little evidence that school had any significant influence on these students' decision to study the STEM-related subject of engineering in HE. Nevertheless, elements of influence from their experience at High School did appear in some of the students' interviews and will be discussed in this sub-section.

4.2.1.4.1 Higher Education exhibition visit.

Of the students who were asked if they attended HE exhibitions or fairs while at High School or if advisors came to their school to talk to them about their HE options, many either could not remember (Student #5; Student #13), which could suggest that they either did not attend one of these exhibitions or it had no impact on them, or that their school did not organize this for them (Student #2; Student #8). Student #11 shared that their school had "a lot of…presentations" (line 24), but these appear to have been organized by the teachers at this school rather than outside agencies. Similarly, Student #25 shared that a teacher at her school ran a personality test for students, but this was the extent of their career and future study guidance.

By contrast, Student #37's school organized a fair internally at the school to inform students of their HE options, but it appears that this student was also proactive in seeking out external exhibitions and events which promoted HE too:

> "And even when I went to the Open Day, to one of the universities in Sharjah, I went to…like, different. I went to Engineering. I went to Science. I went to…to see myself where." (Student #37, line 34)

Indeed, while seeking the most appropriate major for her through these open days, she also discovered that engineers were in high demand in the job market:

> "…it was maybe one of the Fairs, that one of the universities said that they found statistics that so many are involving Business and other and they're leaving... They would, like, show what the country wants, like, they want teachers. They want doctors. They want engineers. But you wouldn't see a lot of, like, Business and stuff like that. They don't want it. But they will find other professions that they need. Especially teachers. Especially engineers and doctors that they're high profession." (Student #37, line 86)

Student #20 also attended a formal HE exhibition with her school. At the time of this visit she actually wanted to study Law, but she visited the stands related to engineering too to ensure she had a second option available to her:

> "But also I looked at Engineering because I wanted it to be the second choice." (Student #20, line 102)

4.2.1.4.2 High School curriculum designed to encourage students into STEM.

It also appears that the UAE High School curriculum has changed in recent years to include more Science subjects than the ones previously offered to students:

> "…started to build Math and Physics…because we…we were not taking Physics before. We…we just summation of all Science subjects in one subject. Which is called Science." (Student #1, line 118)

Although Student #1 shared that this had not influenced her decision to study engineering as it was not available when she was at school, she suggested that the change in curriculum could have had an impact on other students opting to study STEM-related programmes in HE. Her viewpoint on this was substantiated by reflections on the choices made by both her sister and niece who were both younger than her, as both had chosen to study engineering (Student #1).

This idea was also reflected in Student #12's interview responses as she chose engineering at tertiary level "because of [her] school" (line 128). This was a technical school

which taught "according to majors"(line 110), so she had studied aircraft engineering for two years prior to joining the engineering division at *the institution*.

Staff #2 also commented on the fact that the students who came from these technical schools, where the curriculum is more focused on STEM-related subjects, were academically stronger in their foundational engineering courses:

> "Well-prepared. They're already prepared before here joining…" (Staff #2, line 84)

4.2.1.4.3 Increased Math in High School prepares for college.

One student commented that an improved Math syllabus in High School could be contributing towards an increase in students choosing to study engineering at HE level as they are better prepared for this subject:

> "I think that a lot of students are learning more Math and I think they're liking it. That's why when it comes even more they're gonna still pick Engineering…..and it's gonna be easier for them when they already know half of it from school." (Student #11, line 60)

4.2.1.4.4 High School teachers' encouragement.

Two students shared their experiences of High School teachers' having a direct influence on their decision to study engineering:

> "…when I about to graduate. I just think about it. When they encouraged me…my teachers." (Student #2, line 30)

> "Some of them they was telling us to, like, if you're studying Engineering…" (Student #5, line 144)

By contrast Student #11 shared that her teacher had encouraged her in Math, which indirectly contributed towards her decision to study engineering in HE:

> "He encouraged me to do Math. And then when I did it, I really liked myself and I liked Math. So that's why I chose Engineering." (Student #11, line 14)

4.2.1.5 Securing their future.

The recurring idea of securing their future appeared throughout the student interviews. Either in the direct form of job security or employment in the government sector or, alternatively, in the belief that engineering salaries are potentially more lucrative than those of other career paths. This belief that engineering graduates have access to improved employment opportunities was echoed by Staff #1 who shared that although the students themselves may not have been aware of the current job market, it was likely that their parents were:

> "…probably students are not aware of the job market, but families…and most of them are." (Staff #1, line 98)

Staff #3 also confirmed students' perception that there would be increased employment opportunities if they graduated as an engineer, but suggested that it was likely to be based on their major:

> "A perception that eh, y'know, they feel that the market is…eh, full of opportunities if you are an engineer compared with others. Eh, but, eh…on reality that might not be the case. It depends also on the concentration, y'know? Whether they choose to have, like, y'know, Communications Engineering versus Electronics versus maybe Control Engineers. So, it varies. Em…but yeah…the perception is that engineering, eh, y'know, has more offers and better pay." (Staff #3, line 82)

4.2.1.5.1 Desire to work in the government sector.

One of the questions which appeared in the online questionnaire, but was explored further in the student interviews, was whether students hoped to work in the government or private sector upon graduation. Two-thirds of the students shared that they would prefer to work in the government sector:

> "Government of course." (Student #2, line 78)

The reasons given for this aspiration were largely related to securing their future rather than due to the type of work available in this sector:

> "It depends on the salary, on the…like, em…insurance and everything. But, if the government have good reputation, then I will go to government." (Student #1, line 198)

> "A government sector is better so you assure yourself that you won't get fired any time. You can have insurance. Private sectors, they can fire you any time without insurance." (Student #11, line 52)

> "…I will go for government, so it's better for like an Emirati woman…" (Student #12, line 88)

> "…I'm focusing more on the government because…eh…whenever something happens in the future. If you got tired from…if you got fired from your job or you retired…eh…the government still plays an important role…" (Student #21, line 62)

> "…government will like, y'know, will appreciate you more…will give you your property or your…the things you need. OK, but, eh, like the private…the…company…the rules are different…[…]…Also the vacations are the same as the kids', the family, the rules…because of the rules. Not because of the salary or…because of the rules and the process of each company is different, but the government is more helpful for the employer here." (Student #32, line 14)

In fact, some of the students shared that it might be more interesting or more worthwhile to gain experience from working in the private sector, but their long-term goal was still ultimately to gain employment in the government sector:

> "Maybe I will start in…in…eh…private company…then I will change." (Student #17, line 72)

Their interest in securing a government job also appeared to be related to securing their future through the guarantee of a pension on completion of their tenure in the government sector:

> "We want government to finish 25 years and if we want to go out, so we have a salary." (Student #1, line 222)

Of the students who commented on this, there appeared to be a belief that this would not be an option through the private sector:

> "Privates don't give, em, if you quit or something they don't give you the money for retirement…" (Student #11, line 54)

There was also an aversion to the perceived and/or existing rules that private companies enforce (Student #32; Student #37). One student shared that most of her family were working in the government sector at the time of this research and that they had suggested to her that the private sector would be a tougher, less flexible place to work (Student #37). Although these were assumed rules for most of these students, as they themselves were not employed by the private sector nor were their family members, one of the interviewed students could personally vouch for the difference in rules as she was employed in the private sector while also studying at *the institution*. This student commented that her desire to move to the government sector was influenced by her disdain for the rules of the private company she was working in (Student #29). This perception that the government sector provided better working conditions was also confirmed by Staff #3:

> "…they say, eh, y'know, we really prefer to work in the government sector because… Y'know, when I ask them why they say because working hours are, eh, much less compared with the private sector. And it's more flexible for them." (Staff #3, line 88)

Although the majority of these students aspired to work in the government sector, they also appeared to understand that these government sector jobs would be more difficult to acquire, compared to private sector jobs, even in the field of engineering:

> "Government is full. Especially, like (*institution name*) is telling us that, eh, you should enter private sector because government is full." (Student #1, line 204)

Staff #1 confirmed that this current situation in the job market:

> "…there are government jobs in engineering, but it seems the majority are in the private sector." (Staff #1, line 104)

One student shared that she would like to work in the semi-government sector (Student #20). Only two students said they had no preference between the government and private sectors (Student #5; Student #25), although one of these students clarified this statement by saying she had no preference as long as it was a "good place" (Student #25, line 25). This was echoed by another student who initially shared that she would prefer to work in the government sector, but later said she would really like to look into both possibilities and then choose the sector which was most beneficial to her (Student #37).

The idea of gaining relevant and valuable work experience by working in the private sector was echoed by two students who suggested that working in the government sector was limiting in this regard:

> "…like, getting experience is just two to three years. You will know new things. The rest is just repetition." (Student #1, line 194)

> "I heard about so many ladies who worked in government for five years…and then, it's like…as if they worked only for one year. From the things they have worked on, because I think in government when you go they just give you one task and this task, you cannot change it, you have to go through it for a long time. While in private, no, you <u>can</u> improve, you <u>can</u> change, you <u>can</u> give your ideas." (Student #23, line 74)

4.2.1.5.2 Good salary.

Another response which was captured in the students' answers to open-ended question #23 (Appendix H), and was similarly reflected in the student interviews, was the belief that engineering graduates had the potential to secure a lucrative salary:

> "…the salaries of the engineer are like really high…" (Student #8, line 54)

> "In Engineering it gets high salary. More than the other jobs." (Student #32, line 116)

4.2.1.5.3 Future employment opportunities.

All of the students expected to be employed upon graduation, either on graduating from their BAS or upon graduating from further education such as a Masters or Doctorate:

> "I am going to finish the Bachelors, I'll finish the Masters first. And then…go to work." (Student #5, line 200)

In fact, one student was purposefully planning to study a Masters upon graduating with her BAS to improve her chances of employment:

> "For my Masters I wanna study outside the country…and get my Masters there for Aircraft…. I'm thinking of one job that I would really like to get…if I studied Engineering Electrical then I did Aircraft it's gonna be a huge certificate that's gonna stand out, so I hope they choose me." (Student #11, lines 40-42)

When asked if they wanted to be employed as an engineer upon graduation, most students were surprised that they were asked this question:

> "…I actually think I won't be studying Engineering if I wasn't planning on working on it…" (Student #8, line 24)

As reflected in the students' answers to open-ended question #23 (Appendix H), eleven of the fifteen interviewed students held a similar belief that engineering graduates had access to increased employment opportunities, in contrast to graduates from other divisions at *the institution*:

> "the Engineering seems more like…highly anticipated and highly wanted,…and they are more wanted, so…especially for now and our vision of the country." (Student #8, line 54)

> "Engineering has a lot of opportunities for jobs." (Student #11, line 8)

> "…UAE needs engineering students…" (Student #12, line 126)

> "…they are searching for technology and engineering graduate…especially in the engineering field…" (Student #21, line 48)

> "But now Engineering is growing and…they need Engineering…graduates." (Student #23, line 118)

When referring to sought after majors, Student #25 shared that engineering graduates were most in demand in the UAE, while they were the fourth highest in terms of speed of employment in the country (Appendix G).

4.2.1.6 Fulfilling a national agenda.

One striking idea that emerged from this data was the indication that these students believed that they could or should be contributing towards the development of their country. Indeed, Staff #1 shared the government's encouragement for Emirati women to contribute towards all aspects of the country's development, even the traditionally male-dominated field of engineering:

> "…what's obvious is that the UAE government strongly encourages women to be involved in all aspects of the public life, including, eh, jobs, education, et cetera. Eh, so engineering traditionally is not a female area, eh, but with the…eh, support of the government we found more families and more female students choosing engineering to be involved in that field." (Staff #1, line 98)

4.2.1.6.1 Contribute to their country (the UAE).

Almost half of the students made reference to studying engineering to be able to contribute towards their country:

> "I wanted to do something and make a difference." (Student #8, line 12)

> "Engineering has a lot of opportunities for jobs. Here because you can innovate the country, you can do a lot of things." (Student #11, line 8)

> "I want to be something in the future…For my country." (Student #29, lines 52-54)

"I will do something…like maybe something new in our country. Something that could be helpful to them." (Student #37, line 144)

Student #21 suggested that students are choosing to study engineering as contributing towards their country will give them a sense of national pride:

"…in the future…as we know, women plays an important role in our society, so…like…as if, like…they are feeling proud of themselves." (Student #21, line 80)

4.2.1.6.2 Need for engineers in the UAE.

Two-thirds of the students were also aware of the need for engineers in the UAE, particularly Emirati engineers, to develop the country:

"…engineering is really…wanted…in UAE." (Student #1, line 228)

"Engineering seems more like…highly anticipated and highly wanted…and they are more wanted, so…especially for now and our vision of the country." (Student #8, line 54)

"Engineering has a lot of opportunities for jobs." (Student #11, line 8)

"…you'll have more jobs. You will have, like, everything. Now what they need is Engineering." (Student #13, line 76)

"…they are searching for engineers, especially Emiratis…" (Student #21, line 56)

"But now Engineering is growing and they are building, eh…companies and this for engineering and they need Engineering stud…(stops before completing word 'students')…graduates." (Student #23, line 118)

"They want engineers." (Student #37, line 86)

Student #25 also shared a newspaper article showing the majors which were most in demand in the UAE and fastest to be employed (Appendix G). This newspaper article, which was sourced from the UAE Ministry of Education, also correlated with the need for more students to opt to study STEM-related subjects, including engineering, in the first place:

"UAE just encouraged us a lot to enter these things. These majors." (Student #1, line 136)

"…UAE needs engineering students…" (Student #12, line 126)

This need for engineers in general in the UAE was confirmed by Staff #1:

"the need for engineering in the UAE in general and Dubai in particular is ongoing. Eh, because of the development, construction, so there's a need for almost every type of engineering. Whether it's Civil, Electrical, Mechanical, eh…eh…because of how Dubai is…Logistics and Industrial and so on." (Staff #1, line 104)

4.2.1.6.3 Need for Emirati females to join the workforce.

Besides a need for engineers in general in the UAE, two students were also of the opinion that the UAE labour market was actively seeking out Emirati females:

"But now, jobs, they want Emirati females for the jobs…" (Student #11, line 44)

"Like, they are more important and they want more womens now." (Student #25, line 134)

This could also be associated with the belief shared by Student #29 that Emirati women are more committed and reliable than Emirati males.

Despite these students' belief that Emirati females were being sought out to join the workforce, they also shared their belief that some engineering workplaces were more suited to males than females. However, this was largely due to the perceived physicality or environment where the job takes places rather than due to the perceived difficulty of the job of engineer itself:

"I'm a female, if I work, em, I can't do it like a fieldwork, because you know that sometimes I might get pregnant, it might affect my health, so it's gonna be harder for me than the men." (Student #11, line 44)

"…if you have Mechanical Engineering all around will be men and it will be, like, something you have to, like, carry, like heavy weights. It will be very difficult for women to work there." (Student #13, line 192)

> "…here in the UAE, eh, women won't, eh…won't accept work in the field or work with machines like in a industry or something…" (Student #20, line 112)

In these instances, it was inconceivable that the unsuitability of the engineering workplaces was due to them being male-dominant or difficult mentally, but rather that the environment itself was unsuitable:

> "No, no, no…environment." (Student #17, line 96)

> "…for the airplane engineering…I think it's difficult for a woman to work…it's not difficult…all of us can work, but I think the environment over there is a little bit has difficulties." (Student #32, line 66)

4.2.1.7 Cultural beliefs.

More than two-thirds of the students held the belief that women are accepted as being equal to men in the context of engineering in the UAE:

> "If…if this woman wants to do the things that the man will…then the role will be similar. It's fine. It's according to the woman." (Student #23, line 64)

This extended to the belief that there was either an equal amount of male and female engineers in the UAE (Student #11; Student #12; Student #13) or more female engineers than males (Student #29). In some cases, students shared their views that women "have more patience" (Student #25, line 13) and are "smarter than the men" (Student #25, line 126), leading to employers preferring to recruit females over males:

> "…they think that females do better work than men, so I think they're trying to recruit females so they can show that they're equal." (Student #11, line 44)

> "…some place they want women more than mens…. Like, they are more important and they want more womens now." (Student #25, line 134)

Indeed, one student commented that the increase in Emirati female engineers is likely to result in more Emirati women engineers in the workplace than men in the future:

> "Ah, for now, I think the…the men are more, but from what I see in my generation and how just more girls are into engineering stuff I think it's gonna flip the ratio." (Student #8, line 40)

It is possible that this may already have started in some workplaces, as one student who did summer training in the engineering environment of DEWA (Dubai Electricity and Water Authority) shared that she saw "lots of old people, like, all ladies" (Student #1, line 76). Additionally, when Student #13 asked her family about employment prospects in their engineering environments, she had been told: "In all place we have, like, maybe one man. All women." (Student #13, line 170). The same student attributed the increase in Emirati females studying engineering in contrast to a reduction of Emirati males to the fact that men are more likely to open a business instead of studying (Student #13). Regardless, several students reported that there were only a few jobs in the UAE that were still segregated by gender (Student #1; Student #37), suggesting that gender equality had started to exist across the full spectrum of the UAE labour market, opening up employment opportunities for these students.

Despite these job opportunities, two students had heard anecdotally that some engineering workplaces preferred men to women (Student #25; Student #29). However, other students felt that this inequality was an issue which could be overcome as:

> "…females can still make it through the Engineer because they're dedicated and they learn fast and they can adapt to their workplace." (Student #11, line 48)

This level of determination may be linked to their confidence in the UAE government's support of their contribution to the development of the country:

> "…with the time the government, UAE President just encouraged, eh, women to do…because, you know…eh…to be engineers…" (Student #1, line 78)

One student attributed this governmental support to a need to fill the workforce as Emirati males are recruited for military service, possibly due to the current political situation in the region:

> "…especially when…when we are facing lots of problems like, eh…political and so on, they want to, eh…men to go to army and police and…eh…girls to study these" (Student #1, line 78)

It is worth noting that despite this growing equality in the UAE, a couple of students shared that some Emirati families still maintained the traditional culture of females being segregated and not permitted to interact with males outside of their immediate family:

> "Like the social now is very different and they are able to work with man and it's fine, but there is a small percentage of some families they…they may differ…of this…" (Student #32, line 118)

> "Like…there's so many families, it's fine with them, like, their children, like, working with men. But some families, no…. Like, eh…I heard, like, one of the students, like, her father doesn't let her work with men. She has to find a job there's only female." (Student #37, lines 158 & 160)

4.2.1.8 Interested in Math and/or Physics.

Perhaps unsurprisingly, some students attributed their decision to study engineering to their love of Math and/or Physics:

> "It was my first programme choice because I'm interested in Math…" (Student #2, line 2)

> "…and I liked Math. So that's why I chose Engineering." (Student #11, line 14)

> "…because I like Math and I interested to…if…I study it…" (Student #17, line 8)

> "Ah…my addiction to Math and Physics." (Student #21, line 14)

> "…actually I fall in love with Physics and I want to be an engineer." (Student #25, line 16)

> "See, Math is my first. OK, Science is not too much, but I want to learn. Like, I want to know everything." (Student #29, line 34)

For Student #20 it was a contributing factor as, although she wanted to study Law, her parents persuaded her to study engineering instead, as discussed earlier.

4.2.1.9 Perseverance to achieve academic success.

As mentioned earlier, despite the common belief that engineering was a difficult subject, there was also a feeling that hard work could overcome the obstacle of lack of ability in the basic foundations of engineering:

> "Yeah. You need to work hard." (Student #5, line 188)

> "It's not that hard, but you need to focus more and study everyday…eh…to be good at it, but it's not hard." (Student #2, line 6)

When asked specifically if hard work could overcome the difficulty of engineering, regardless of whether a student had abilities in Math and/or Physics to be academically successful in this programme, the common feeling was that anything is achievable with enough hard work (Student #13), if you "study hard enough" (Student #37, line 48), and through perseverance:

> "I think that every…we can…everyone can do everything, but of course everything also needs a lot of work and hard work." (Student #20, line 92)

> "Because…eh, like…(long pause)…it's a challenging, em, it's a challenging major, so women, eh, like…or, they <u>want</u> to prove that they can do, they can do it, you know? They can do the hard thing." (Student #20, line 132)

> "if…I put in my mind that I love this thing, I will work hard for it." (Student #23, line 28)

> "Yeah. Yeah. It has…it would be under a big pressure, but if they really want it, they will do it." (Student #25, line 30)

> "Yeah. It's possible. He would say, like 'No. I want to do it. I want to pass. Maybe if I went to university it would be better. I will love the teacher.' So maybe. It could happen. Like, nothing is impossible in this world." (Student #37, line 44)

One student also shared some strategies she had adopted to overcome her difficulties in achieving academic success in this programme:

"I developed myself and I saw the…in the YouTube and search in…in some…in some subjects…" (Student #17, line 22)

4.2.1.10 Following a trend to study engineering.

Only one student suggested that other students could have chosen to study engineering as they saw it as a trend to follow:

"Because most of the girls they do it because others they do it." (Student #2, line 120)

4.3 Summary

This chapter focused on the analysis of all data collected throughout this research study, through the online questionnaire sent to students, along with the student interviews. To triangulate this data, information collected from semi-structured interviews with engineering staff was also incorporated into this analysis.

Overall, it appears that in undertaking the decision to study engineering, several factors were influential on this particular group of students at this specific institution. Although the idea of self was central to this process, other influences including family, high school and UAE society were also revealed (Figure 9). It is also worth noting that all of these influences took place within the arena of UAE culture and were likely to have been influenced themselves by the role of women in the UAE and aspirations of the UAE government for gender equality within this society. This will be further explored and discussed in Chapter 5.

Chapter 5: Discussion and interpretation

5.0 Introduction

This chapter discusses the findings and analysis of the data collected throughout the research study in an attempt to answer the research question and sub-research questions, and to outline the new knowledge that this research has revealed. In addition to this new knowledge, the limitations of this study will also be explored, before arriving at possible recommendations for institutional and national policy, along with recommendations for future research possibilities.

In answering the main research question, it is worth reflecting on the fact that there were almost certainly many different influences on these students in their decision to study engineering at this campus. However, as a result of the findings of this research study, this chapter highlights the most significant influences that emerged through the data collected (Figure 9). Figure 9 demonstrates the complexity of this research in highlighting how the intersectionality between structural variables such as cultural values, national interests and family structures intersected with the students' personal ambitions, aspirations, and traits such as perseverance and self-efficacy as they moved towards pursuing their personal projects. It also highlights the cumulative influences on these students, with globalization and external forces influencing UAE government policy, which in turn influenced change within UAE society. This societal change subsequently influenced Emirati family structure and attitudes within these students' families, with the family acting as a mediator of the nation's vision, as well as extending to changes within the education system, including High Schools. Arrow A (Figure 9) indicates the personal characteristics of these students, while Arrow B (Figure 9) highlights the students' desired future outcomes, which in turn have contributed towards their decision to study engineering at *the institution*.

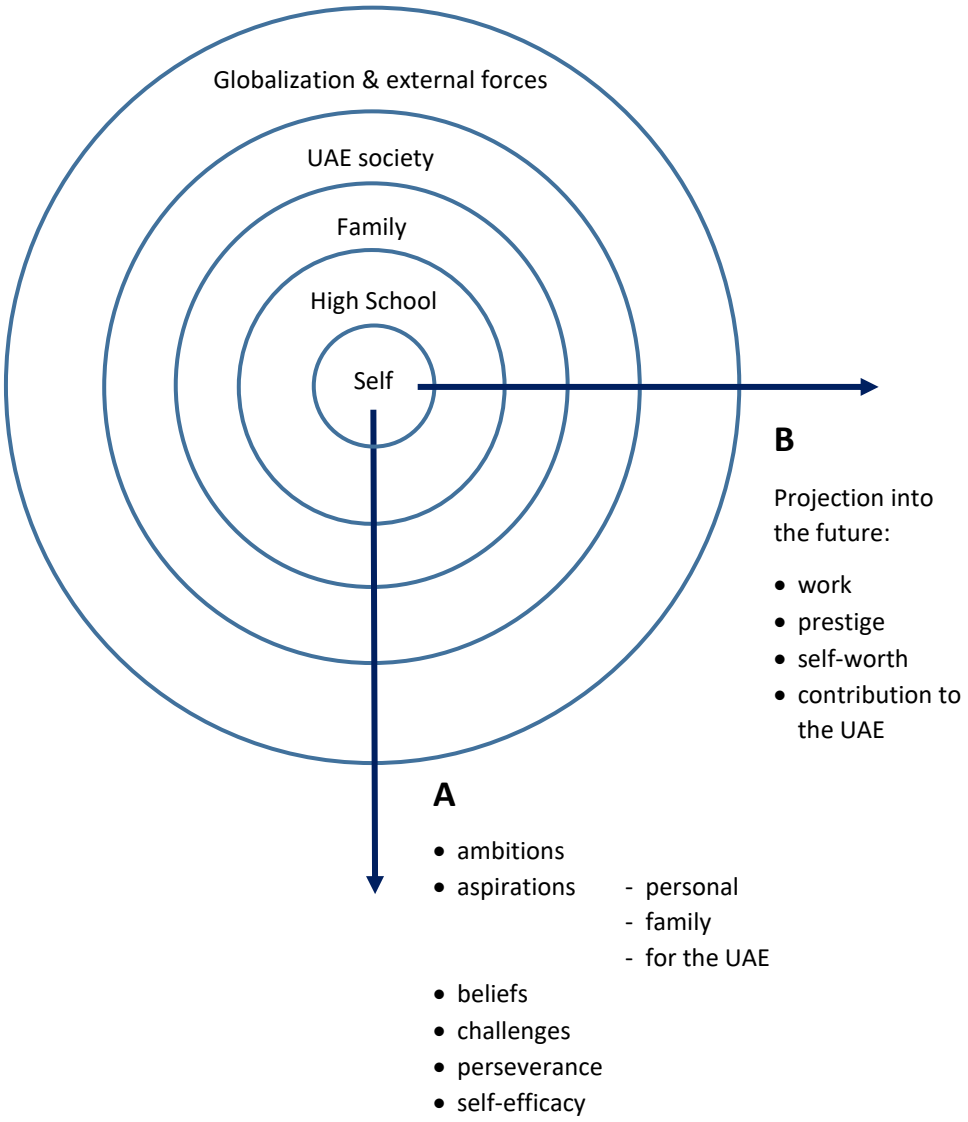

Figure 9: Influences on research participants' decision to study engineering

5.1 Answering the research questions

5.1.1 Main research question.

This research study aimed at addressing the main research question of:

What are the reasons for the current Year 1 and 2 engineering students at this all-female institution to study engineering, and how might this inform local, national, and institutional policy?

While each of the students in this study shared their own personal aspirations, ambitions, and beliefs, in some cases they equally faced challenges to achieve these goals (Figure 9). Armed with these personal characteristics the students then made a choice based not just on these characteristics, but also looking to secure their future within UAE society as a whole (Figure 9). As primary agents (Archer, 1995), although they may have been pursuing their own personal projects within the structural variables of society, family, and Emirati traditions, these projects appeared to largely align with working towards contributing to their country. Therefore, just as these students were given opportunities simply by being born into Emirati society, it is likely that they too had an influence on this strongly-collectivist society. While their actions were not undertaken in the role of corporate agents (Archer, 1995) as they were not directly involved in organizing change for others, simply by making the choice to study engineering and working towards the vision of the UAE, they at once potentially influenced their society while simultaneously opening doors for future Emirati females.

Equally, just as these students were aware of the constraints which traditional Emirati society could place on them in certain contexts, it seems that they were also consciously or unconsciously aware of the benefits which they enjoy from being part of this society, in a sense being "simultaneously free and constrained" (Archer, 1995, p 2).

It is clear from this research that in making the decision to study engineering they were also closely supported and guided by their immediate and extended families. Although it is outside the scope of this research study to speculate, it is likely that these family members also each held their own set of beliefs. However, as these family members are part of such a strongly-collectivist society, regardless of their personal beliefs they would have had a vested interest in securing their female relatives' futures for the greater good of the entire family and Emirati society within Dubai. Again, although it is outside the scope of this research study to speculate on the influences on these students' families, it is relevant to highlight the shift towards STEM-related subjects in UAE society as a whole, as this may have been a strong influence on these students' decision to choose to study engineering at this campus.

5.1.1.1 Self: Perseverance and challenges related to engineering.

Contrary to Matusovich et al's (2010) study, influenced by Eccles et al's expectancy-value theory, which suggests that future engineers are recruited based on "competence and value beliefs" (2010, p 289), it would appear that even though some of these students struggled with the core engineering subjects of Math and Physics, therefore potentially lacking the competency to succeed academically, they still chose to study engineering. Indeed, evidence of their perseverance to achieve academic success in these subjects despite the obstacles this presented was provided in the previous chapter.

Therefore, it would appear from these findings that these students were resolved in their decision to study engineering, regardless of whether or not they found the subject much more challenging than expected, and regardless of their initial competency in the core subjects needed to succeed in this major. In some ways this aligns with the predominantly Eastern view that hard work can overcome a lack of natural talent in this field (Marginson et al, 2013), but certainly points to these students choosing to study engineering due to a desire to graduate in engineering rather than due to their strong abilities in this subject. Although this slightly contradicts Wang and Degol's (2017) suggestion that both ability and interest are needed to choose math-intensive STEM majors, it could also suggest that the students' strong interest in being engineers outweighs their lack of ability in the core engineering subjects. Taking into account Bandura et al's claim that "occupations […] serve as a major source of personal identity and self-evaluation" (Bandura et al, 2001, p 187), these students' desire to be engineers appears to have compensated for the challenges they face academically in this major. Indeed, this research study points to the fact that these students viewed the role of engineer as part of their identity at both the time of their interview and also when visualizing themselves in the future. This aligns with the suggestion that females in the West are unlikely to choose to pursue careers in engineering as they conflict with their personal identity (Archer et al, 2013), while the students in this research study identify strongly with being engineers. Although I did not interview students who were not engineers, these student's strong sense of identity as engineers also removes the suggestion that they are only choosing to study engineering for

employment opportunities or for the perceived prestige, as they firmly identify with the actual role of engineer.

Besides identifying as engineers, these students had a strong self-efficacy related to their belief that they would succeed in their engineering studies despite the challenges they faced in core subjects related to this subject. As discussed in Chapter 2, it has been suggested that perceived self-efficacy is more powerful than any other factors in this regard and can be seen as a "pivotal factor in career choice and development" (Bandura et al, 2001, p 187). Therefore, the high sense of self-efficacy in these students, despite their acknowledgement of the fact that engineering was such a challenging subject for them, aligns with the idea that low self-efficacy has been linked to female students not choosing STEM subjects (Bandura et al, 2001). It is also possible that these students' families had an influence on their self-efficacy in math and physics, as in Bandura and colleagues' (2001) study. This parental influence may also have extended to influencing these students' occupational self-efficacy to the extent that they strongly identified with the role of engineer, unlike the female children in Bandura and colleagues' (2001) study whose parents' beliefs influenced them into traditionally-gendered occupations and contributed to their limited self-efficacy in math.

5.1.1.2 Self: Fulfilling a national agenda - a sense of pride through contribution to society.

It is possible that choosing a major which they found difficult, but that is linked to contributing towards the development of their country, provides these students with a sense of pride and self-worth. Indeed, it has been asserted that HE has the potential to contribute significantly towards "developing national identity and feelings of solidarity at a higher level than that of clan or tribe" (Martin, 2003, cited in Burden-Leahy, 2009, p 530). Therefore, I can theorize that studying engineering in HE provides these students with an even stronger connection with their emirate and their country as they believe they can make a positive contribution to their development upon graduation. Indeed, it is likely that this belief in the personal contribution they can make to Dubai and the UAE overrides any hardship or doubts they had about choosing to study engineering at *the institution* if it ensures a future connection

in developing the country. Certainly, these students had five other majors which they could have chosen to study instead at the same institution. When Student #29 was asked how she kept going through the difficulties of studying engineering she admitted that she did not know. However, it is worth considering that this sense of self-belief related to contributing towards her country added to her motivation to succeed in engineering as she shared her desire to be part of its development.

Having this belief that success is possible through hard work and perseverance could also be a by-product of growing up in the environment of Dubai, where there is a general belief that nothing is impossible. Indeed, the ruler of Dubai has publicly stated that nothing is impossible in Dubai on numerous occasions (HH Sheikh Mohammed, 2013). As these students are largely from Dubai and belong to such a strong collectivist society, their aspirations to support their country are also likely to align strongly with the ruler. Therefore, it would appear that their ambition to become engineers is also partially related to the idea of fulfilling a national agenda through contributions to their country's development, as supported by government policies to promote STEM-related study and career pathways. Although engineering appears to be a difficult BAS for many of these students, they are aware of both the availability of employment in this sector compared to other sectors such as business, along with the country's aspiration for them to work in this field, as are their families. By choosing to study engineering and potentially graduating in this major, they place themselves in a position to be able to play a role in the development of the UAE.

The findings of this research also highlighted some of the students' beliefs that women needed to graduate as engineers to contribute towards the field of engineering due to the lack of male graduates in this field. These students believed this was partially due to the difficulty of the subject for Emirati males and that Emirati females' dedication and determination to succeed in their studies was stronger. However, they also believed it was due to the need for Emirati males to take part in mandatory military service thereby excluding them from HE.

As this research took place during the UAE's Year of Zayed (UAE Ministry of Presidential Affairs, n.d.), which was a year dedicated to the founding President of the UAE, the idea of

patriotism and a sense of purpose in building the future of their country was probably also at the forefront of these students' minds during their interviews.

5.1.1.3 Self: Securing their future.

In contrast to the situation almost ten years ago, where it was suggested that female Emiratis were not aware of the career opportunities available to them in the field of engineering (Aswad et al, 2011), this research demonstrates that this group of students were very much aware of the current state of the job market and the opportunities available to them. In fact, in the last ten years it has been documented that the highly sought-after government sector job opportunities which these students aspire to are now in short supply (Nelson, 2004). Although this particular avenue of information may have been outside the realm of these particular students' notice, other family members may have been aware of this situation either through documentation such as this or through their own personal experiences, as alluded to by Staff #1. This also aligns with the assertion that an awareness of the employment opportunities available upon graduating with a STEM-related qualification is more likely to encourage females to choose to study these majors (Christie et al, 2017; Kho, 2016).

Kemp (2013) confirms that one of the reasons for females in the UAE to aspire to employment in the government sector is job security. Regardless, the fact that these students all plan to be employed upon graduation directly challenges the idea that Emirati females study, but do not plan to work upon graduation as suggested by Burden-Leahy who stated that "education is viewed […] as an acceptable reason for daughters to be outside the home environment, whereas employment has yet to become generally acceptable" (2009, p 536). Expecting to be employed upon graduation also highlights these students' understanding of the protection and economic mobility that the financial security of an engineering profession can provide them (Abdulla, 2005; Kemp, 2013).

Regardless of whether or not the UAE government is now encouraging female Emiratis into STEM-related fields such as engineering, this awareness of the job market and the opportunities available to engineering graduates, regardless of gender, is another pivotal reason for these students' decision to study engineering at this campus. Indeed, while

contributing towards their family as a collectivist group appeared to be an influence, which will be discussed in the next section of this chapter, this ran parallel with the idea of securing their future. Although this initially appears to be the trait of a member of a society with strong individualism i.e. they are working towards securing their own individual futures, in the case of these students the idea of securing their future can also be attributed to contributing towards the family, whether this is their own nuclear family or as part of a larger extended one, which will include their own future family.

5.1.1.4 Family.

Dick and Rallis (1991) use the term *socializers* to refer to people in these students' lives who may have influenced their career choices. As in Dick and Rallis' study, it is worth noting that this influence is unlikely to have been one directional as these students' experiences may also have shaped their own aptitudes which in turn influenced the socializers' "attitudes and expectations" for these students (1991, p 283).

It is clear that socializers played a prominent role in these students' choice of major. In almost every case, students were encouraged, supported or convinced to study engineering at tertiary level education. In fact, of the students who were interviewed, only one believed that her family were unaware of her current major and this was not due to the student's shrewdness in disguising her major, but rather due to being the youngest in an extended family that would support her regardless of the BAS she was studying (Student #12). Equally, this particular students' aptitude for Math and Physics may have influenced her *socializers* into believing that she was capable of studying engineering and of being successful in this major, which could have resulted in either their direct or indirect influence in her decision to study engineering, as also described in Dick and Rallis' (1991) study.

Nevertheless, the *socializers* who have emerged as prominent influences on these students, based on the data collected throughout this research study, are their family members, both immediate and extended. In fact, the majority of these students' families supported their decision to study at tertiary level and a third of these families specifically

aspired for their female relatives to study engineering in HE, sometimes despite the aspirations of these students who wished to study other majors.

In UAE society, as these students are part of an extended family group, all members of their family feel a responsibility towards their success and will likely influence their decision in favour of the overall success of the family (Hofstede Insights, 2018). Equally, these students' are likely to embrace the influence of their family, as loyalty is such an important part of both Emirati culture and being part of a collectivist society. It is worth pointing out at this stage that beyond Emirati family and the state there is very little other society, to the extent that this space has been described as "sparsely populated" (Krause, 2008, p1).

Emirati families still have considerable influence over their female relatives, which can be further confirmed by this research study. However, this research has shown that in this particular instance this influence appears to be towards the general progress of the family and the country rather than, as has been suggested in some literature, as an oppressive type of influence which prohibits these female relatives from establishing careers if this involves interacting with males outside of their immediate family. In many of these student interviews it was clear that their family had aspirations for them to be part of the engineering community regardless of whether these females would be interacting with males outside their family or not. It is possible that this could be due to the number of female relatives that these students already have in this field or due to the existing number of prominent Emirati females in engineering. It could also be due to the wider collectivist society, as the UAE government promotes gender equality and women's place in this field, as suggested by Student #1 when she shared the current political situation and the need for Emirati females to take on roles and responsibilities previously taken by Emirati males who are now required to do military service.

Although the employment of these female students is outside the parameters of this particular research study, I can speculate that this move towards securing engineering jobs contrasts with Abdulla's research just over ten years ago which suggested that Emirati females would face difficulty in securing employment due to their families' "code of modesty" (2006, p 10) expecting them to secure employment in segregated workplaces. Indeed, her article was a

call for this to be addressed to "allow women to fully contribute to the nation building process" (Abdulla, 2006, p 10). Therefore, although it may have initially seemed surprising that these students' families had influenced their female relatives into a career which was still largely male-dominated, especially given the traditional culture of the UAE, it seems more likely that the idea of a collectivist society moving towards a government vision has contributed towards a shift in mindset, leading to an acknowledgement of the need for all members of Emirati society, including females, to be part of this development. It is likely, therefore, that this highlights a shift in these families' views towards the government's initiatives of improved gender equality and a knowledge-based economy by 2021 and in turn highlights a shift in society, as also discussed earlier.

It is also worth considering that the students' female relatives who were already studying and working in the field of engineering at the time of this research study had already paved the way for these female students to enter the same field with their families' support, thereby removing any potential stigma which could have affected their decision.

5.1.1.5 High School: A shift in school curriculum.

Abdulla stated that government schools in the UAE "reflect social and gender norms" (2005, p 30), reinforcing the role of women in society. This is an important idea to consider given the fact that in recent years the UAE school curriculum has shifted to incorporate more STEM-related subjects into the curriculum. It is also worth considering the impact that these schools could have on society given the fact that education has been seen as "a major catalyst of cultural changes in the UAE" (Khelifa, 2010, p 26) and the fact that the same curriculum is taught to Emirati females and males.

Indeed, it appears from this research that those students who were exposed to additional STEM-related subjects, including engineering, through this newly revised curriculum focusing on these subjects at High School, were subsequently more aware of these subjects as possibilities for them in HE. This supposition was referred to by Student #1 who shared her belief that her sister and niece had both chosen to study engineering in HE based on the fact that they had studied the new STEM-based curriculum at High School. As with Christie and

colleagues' (2017) Australian study, this was also confirmed in Aswad et al's (2011) study in which it was determined that Emirati students with little exposure to STEM-related subjects were less likely to choose these subjects as they were not aware of the career options available to them on graduation. Although it is outside the realms of this research study, it is likely that the UAE government would have considered this potential shift in mindset prior to changing the UAE secondary school curriculum to have a focus on STEM-related subjects.

5.1.1.5.1 High School: Teachers.

Although it is likely that the school curriculum had an influence on some of these students' decision to study engineering, this research indicates that their High School teachers had less of an influence on this decision. Indeed, the results of the interviews show that while some teachers directly encouraged these students to study engineering in HE, others did not. Ultimately, however, this does not appear to have had any significant factor on the majority of these students' decision to study engineering, if at all. This appears to be in contrast to studies in the West, where teachers have been considered to have a significant influence on this decision (Dick & Rallis, 1991; Powell & Boyd, 2012).

Instead, the *socializers* in this context with the most influence on these students appear not to have been their High School teachers, but rather the students' immediate and extended family, as mentioned earlier, which aligns with the tribal, collectivist nature of UAE society. In fact, overall, High School teachers appear to have had minimal influence over whether or not these students chose engineering or any other BAS at *the institution*.

5.1.1.6 Society: A shift within society.

As the UAE has grown exponentially since its formation in 1971, the rate at which the society has had to adapt and change has been considerable. As mentioned earlier, in the space of just one generation it has moved from being almost completely rural to predominantly urban. To continue with this progress, in recent years the UAE government has recognized the need to move towards a knowledge-based economy by 2021 to enable diversification of the economy, which is largely based on oil and gas (Aswad et al, 2011). To ensure this vision

becomes a reality, the UAE government has also recognized the need to maximize the participation of all Emiratis in the workforce, both male and female, and for both genders to graduate from STEM-related majors, including engineering. This is noteworthy as although there are more female Emirati HE graduates, they currently consist of only 32.4% of the current Emirati workforce. Indeed, within the geographical context of this particular research, Randeree and Gaad go so far as to comment that involving women in the workforce would specifically "help in alleviating many of Dubai's problems" (2008, p 70). It is also noteworthy as, despite the pace of change, even recent studies have commented that Emirati society is still largely conservative and patriarchal (Alzeer, 2018), with some families still placing restrictions on whether or not their female relatives can work and in which type of environment (Bristol-Rhys, 2008).

It appears from the findings of this research that the government's initiatives to promote women in employment have succeeded in contributing towards the expansion of Emirati society's perception of women's roles within Dubai society to include the role of engineer. Indeed it would appear that by promoting gender equality in all sectors of society, they have also expanded the acceptance of society to encompass women in areas of the workforce which were previously considered to be only suitable for Emirati males. Even the perceived prestige associated with this profession appears to have extended to female engineers too. This is in direct contrast to the findings of Aswad, Vidican, and Samulewicz less than ten years ago, as their study showed that one of the reasons that Emirati females were unlikely to choose to study engineering was related to UAE "society and culture not supporting such careers" (2011, p 566). This newly-expanded perception of Emirati women's roles in Dubai society has therefore likely served to increase the number of female graduates seeking to join the workforce, with an increased interest in being part of STEM-related fields, including engineering.

It appears therefore, that instead of Emirati women having to adapt and conform to the predominantly-male environment of engineering as has been seen in Western countries (Gill et al, 2008; Powell, Bagilhole, & Dainty, 2009; Stonyer, 2002), even to the extent where women

enter the engineering workplace not as woman but "conceptually as men" (Ranson, 2005, p 145), society in the UAE has grown to encompass the concept of women maintaining their female identity while still being employed in this field. Indeed, whether or not the UAE government are aware of their potential influence on this current situation, Henwood (1998, cited in Walker, 2001) suggests that creating an environment where women can be engineers while still maintaining their femininity is an appropriate strategy to incorporate more women into engineering.

Certainly, this idea is reinforced by the experiences shared by the first female Emirati engineer to work at an off-shore gas plant in the UAE. In 2014 she shared that she felt out of place when she first started working at the off-shore plant and even for several months afterwards, but eventually the men in this industry became accustomed to her and eventually began to "treat [her] as an engineer" (Swan, 2014, para 7). This change in behaviour towards this Emirati female engineer and an acceptance that she was an engineer like them was not as a result of her conforming to a male identity or fitting into the male environment she was working in as she specifically stated that she did not "[compromise] her culture or values" (Swan, 2014, para 9). Instead, it was as a result of the male employees at the plant accepting her both as a female and as an engineer and adapting to her within this environment rather than her adapting to an all-male environment. Certainly, contrary to Stonyer's (2002) research which suggests that female engineers need to conform to an identity which is largely seen as male to be successful in learning engineering, these students identify exclusively as being female with a strong sense of femininity. This strong sense of femininity was evident in their comments related to women being "gentle" (Student #11, line 48) and to their belief that some engineering roles demand physical work or field work which Emirati women should not be expected to do. Indeed, identifying as being strongly feminine aligns with Alzeer's (2018) research in which Emirati women saw their femininity as part of their status and something to be protected.

In his US study, Eccles (1986, cited in Dick & Rallis, 1991) suggested that traditional male-stereotyped jobs were perceived by women to be more difficult than female-stereotyped

majors, although they were not seen as more important. However, the findings of this research study in Dubai indicate that although these students viewed engineering as more suited to males in some circumstances, this was due to the perceived physicality of the engineering workplace rather than any perceived difficult of the occupation of being an engineer. This suggests that these students had never considered altering their identity to fit into a male environment.

It would appear then that while Western discourse related to women in engineering largely revolves around the identification of engineering as masculine, in the context of Dubai it would appear that the proposed Western solution of increased women in this field to solve this issue (Rohatynskyj et al, 2008) is irrelevant as the field of engineering is expected to adapt to the femininity of Emirati females in this context rather than females adapting to the field.

5.1.1.6.1 Society: Cultural beliefs and gender equality.

Regardless of some of these students' perceptions of some of the roles of an engineer, the idea of gender equality features prominently throughout the student interviews. Indeed, gender equality has been echoed in the sentiment of the UAE's leadership since its formation in 1971 (Peck, 2001), with the first President sharing his wish that Emirati women contribute towards the development of the country (Alzeer, 2018). Recently this sentiment was reinforced by the current President of the UAE as he issued a directive for 50% of the Federal National Council (FNC) to be made up of women after the next FNC election (Badam, 2018), encouraging more women to be part of the UAE government. This decision also aligns with the government's drive to encourage more women into the labour market and to empower them in general (Badam, 2018). Certainly the United Nations identifies the empowerment of women as being related to the ratio of women in governmental positions, along with the number of both women and men aged 25 or above with high school education (UNDP, n.d.a.). In an effort to address gender equality the UAE has climbed to 34th place on the Gender Inequality Index (GII) since 1990 (UNDP, n.d.b.), with the government's aim to be in the top 25 countries globally by 2021 (Badam, 2018).

Although it appears from the findings of this research that some Emirati families still maintain the UAE's traditional culture of segregating females from males who are from outside their immediate family, other families embraced the government's vision of gender equality. In fact, Student #1's family appeared to understand this fully, as she commented that her father had even offered her the chance to study abroad:

> "He said 'If you want to go out…if you have the opportunity, that's fine. You are going to study and I trust you'." (Student #1, line 246)

This does not negate the other families' sense of protection of their female relatives, but illustrates a move towards a general openness for Emirati women in Dubai to take their place in UAE society and contribute towards the country's development. Indeed, many of these students' families appear to have understood that for their female relatives to be able to contribute towards the UAE government's vision of a knowledge-based economy by 2021, it is imperative that they are employed. There also appears to be a general consensus that the field of engineering is the most likely field for this to take place for these students, even though it is almost certain that they will be working alongside men. This was confirmed by Staff #1 when stating that Emirati families are aware of this situation, but also understand the government's wish for women to be part of all aspects of public life in the UAE and to contribute towards the country's development.

Indeed, the need for UAE nationals to take their place in the workforce is strongly supported through the government's Emiratisation programme. This extends to female Emiratis too as the UAE moves towards improving gender equality within society and views men and women as "equal partners in society" (Embassy of the United Arab Emirates, 2019). This was further reinforced at the World Government Summit (WGS) held in Dubai in 2018 where the UAE Minister for Foreign Affairs and International Cooperation urged Emiratis to move away from the choice of non-STEM-related subjects such as Business in favour of STEM-related subjects. As the UAE has a particularly strong power-distance culture, scoring 90 on Hofstede's cultural dimensions (Hofstede Insights, 2018), this type of directed advice and guidance from a member of the UAE government is very likely to be adhered to by Emirati

society in general. It is also likely to have influenced both the students and their families when making the decision to study engineering at *the institution*.

This is also noteworthy as in Finland, where strong equality policies are in place, the number of females in STEM-related HE majors is still minimal, unlike the Dubai context. Although it is outside the scope of this particular research study I can speculate that this difference could be linked to the fact that Finland is considered to be a strongly individualist society (Hofstede Insights, 2019a), in contrast to the UAE's strongly collectivist society.

Bearing in mind the limited Emirati population, the recent implementation of mandatory military service for Emirati males between the ages of 18 and 30, and the ratio of female Emirati HE graduates to males, it is even more imperative that Emirati females choose to study and graduate from STEM-related majors to address the need for STEM graduates to contribute towards the development of the UAE and the building of a knowledge economy in line with the government's Vision 2021.

Randaree and Gaad comment that the rise of women in "leadership positions has led to a liberalization of views in the UAE and has been embraced by Dubai in particular" (2008, p 70). Therefore, although not many of these students shared specific female role models who influenced them in their choice of HE major, it is likely that the general shift in society towards gender equality and the overall promotion of female role models had an influence on them in general. As the government plans to move towards a knowledge-based economy by 2021 and there are limited numbers of employment opportunities in non-STEM-related fields, particularly in the government sector, the need for both male and female Emirati STEM graduates is paramount. This is particularly pertinent given the fact that Emiratis are in the minority in the UAE workforce. As the UAE government promotes the uptake of STEM-related jobs as part of a broader drive towards Emiratisation, it is inevitable that gender equality comes to the forefront, as the available Emirati workforce would be considerably minimized through the exclusion of females. Consequently, it is likely that this has also contributed towards these students' desire to study a major previously considered to be the right of men, and for them to

hold a belief in the possibility of gaining employment in this field as the UAE moves towards gender equality.

Indeed, the government has also led by example in this regard, with nine of the thirty-two members of the UAE Cabinet being women (Government.ae, 2019d), which I can speculate has in turn also influenced the expansion of society's perception of women to include prominent roles, including that of engineer.

Despite similar governmental policies designed to support and increase the number of females in STEM-related subjects in Southeast Asian countries such as Cambodia and Indonesia, the growth of female students in STEM-related subjects in these countries has not increased. As discussed earlier, this is likely to be related to the culture of these countries believing that engineering is not a suitable career path for females. By contrast, in China, where gender equity policies were initially implemented under the Maoist regime and continue today under the current Chinese government, the number of females in STEM-related subjects in HE has grown. Although it is outside the parameters of this research study, based on my research I can speculate that the divergence between the Chinese situation and Cambodia and Indonesia is either that the Chinese policies have had longer to be implemented and therefore there has been more time for society to accept them or that Chinese society reacts more positively to governmental policies than other countries in the region. Taking this into consideration and using the context of these Southeast Asian countries to shed light on the Dubai context, the UAE government's policies related to female empowerment have been in place for some time, so it is worth considering that the current Generation Z of Emirati females are the generation who have started to benefit from these policies as society has had time to accept them. Alternatively, as Emirati society in Dubai has emerged from a tribal one, it could also be considered that this society is more responsive to the government's vision, as with the Chinese context.

5.1.2 Sub-research questions.

At the outset of this research, with no knowledge of why these students had chosen to study engineering, sub-research questions were included to gather as much information related to this topic as possible to answer the main research question. In particular, I hoped that the engineering staff would provide rich insights into why their students had chosen their BAS programme. However, over the course of this research it transpired that the sub-questions did not offer rich data in the same way as the main research question did. Instead, they provided complementary information to support the overall study, while the core data for this research came from the students themselves, in answering the main research question. This is particularly true of the first sub-research question, related to students' views. To reiterate, the further sub-questions were:

What, in the view of these current engineering students, are the factors that influenced their decision to study engineering?

It would appear that this sub-question has already been answered through the answer to the main research question, as these students were self-reflective enough to be able to identify and share the same factors which influenced their decision to study engineering.

What insights do other staff at this institution bring to the question of increasing students at the institution choosing engineering?

All three staff members confirmed that there had been a rise in the number of students at this institution choosing to study engineering in recent years. In addition to this confirmation, Staff #1 also believed that the rise in engineering students at this institution was linked to the novelty factor of this major being one of the newest subjects on offer to these students. However, they contradicted themselves later in the same interview by stating that instead of their newest engineering specialism attracting more students as they had predicted, it actually just split the number of engineering students they already had.

By contrast, Staff #3 shared the fact that they did not know the students' motivation for studying engineering, but suggested that students entering this institution had not yet made

their choice of major upon acceptance of a place at *the institution*. This member of staff further speculated that these students were probably influenced by the brief one-day orientation programme that occurs on the first day they join *the institution*, although none of the students in this research mentioned this programme. While Staff #3 could provide no evidence to support this, particularly as this orientation programme is a one-day event aimed at sharing programme information with students who have already made their BAS choice, it raises an interesting point in that it highlights the influence which *the institution* could have in providing future career path counselling to potential students in future. Indeed, based on Staff #3's comment, it is also possible that *the institution* could find ways to engage further with potential students through informational brochures distributed to families through High Schools, prior to this orientation event, along with weekend workshops for families which could promote the majors available at *the institution*, along with the potential career paths they lead to.

5.2 New Knowledge

This research study sought to understand the reasons for the recent rise in the number of Emirati females at *the institution* choosing to study engineering. This rise appeared to be surprising given the literature surrounding this case study which suggested that the UAE still maintained a largely patriarchal society, with Emirati females discouraged or prevented from gaining any employment where they might interact with males from outside their family and given the fact that engineering was still considered a male-dominated field in the UAE.

However, it would appear from these research findings that the considerable change which the UAE has experienced since its formation in 1971 has extended to a slight change in society in the emirate of Dubai in recent years, related to women in society and women in the workplace. Although the families of the female students at this institution still maintain a strong influence on their study decisions and career paths, the UAE's collectivist culture, along with a strong sense of loyalty towards the rulers of the UAE, has influenced families to encourage their female relatives to move towards the field of engineering. Indeed, it is likely that the government policies supporting female empowerment and encouraging all Emiratis to contribute towards the development of the UAE have now impacted Dubai society. It would

appear that they have also extended the acceptable sphere within which Emirati females in Dubai can engage in employment that is deemed to be culturally appropriate. Consequently, this has led to these work environments having to also expand their acceptance to include Emirati women within their workplaces, while removing the need for these women to adopt a different persona or a different personality to be included in these workplaces.

Although these governmental policies have been referred to as "state feminism" (Krause, 2008, p 64) whereby the UAE government supports women's interests but through its own agenda and towards its own interests, it is clear that these particular Emirati female students have benefitted enormously from an increased choice of study opportunities and a wider choice of career options than previous generations of Emirati women. Furthermore, while the UAE may promote their approach to women empowerment through language which the West can relate to in terms of improved gender equality in order to demonstrate their move towards modernity (Schedneck, 2014), I would suggest that this language which is used externally is irrelevant to these students, as they experience firsthand the reality of the UAE's move towards improving gender equality in the public sphere. While some literature suggests that the UAE may be motivated to promote the empowerment of women for extrinsic reasons, such as improving their status related to women's rights internationally, improving their rank on the Gender Inequality Index (GII), and showing its connection with modernity (Schedneck, 2014), the result for this particular group of students is that they are experiencing the benefits of these governmental policies firsthand. Indeed, in Schedneck's (2014) research study, she shared that the Emirati females she interviewed valued the freedoms they currently had and recognized that they did not have to struggle to achieve them as the government had provided these opportunities for them as part of the unification of the country and promotion of Emirati women. Schedneck's (2014) research also shed an important light on the fact that her interviewees suggested that the UAE government was more progressive than many Emirati families. Taking this into consideration, it would appear from my own research study that since Schedneck's research, the Emirati families of these particular students in Dubai have aligned themselves further with the government's vision by strongly encouraging their female relatives

at *the institution* to choose to study engineering and to seek employment in this field upon graduation.

Indeed, it would appear that unlike Singapore's policy of strategic egalitarianism (Lazar, 2001) whereby female citizens were given rights when it aligned with the government's needs of addressing the indigenous workforce, but later had them taken away, the UAE government's policies surrounding women's rights are steady and constant, having consistently developed and grown since the formation of the country. Certainly, evidence shows that the UAE has systematically encouraged females to take up their roles in developing their country and instead of these policies diminishing or being removed, they have increased.

This research further demonstrates that, despite literature within the last ten years signaling a lack of freedom and a lack of gender equality within the UAE, as referred to in literature cited earlier in this research study, it would appear that the government's policies have begun to affect Emirati society. It would seem that this governmental influence has contributed to Emirati women in Dubai being offered more opportunities to study and work in the discipline and career of engineering as it was previously considered to be male-dominated and therefore one which they were discouraged from engaging with. Based on all this new evidence, it would certainly be worth carrying out further research in this area in future to ascertain if this increased gender equality continues and if it extends to other areas too. This could even extend to further gender studies and, perhaps, the acknowledgement that Western narratives surrounding gender equality can be quite different from Eastern ones.

Besides the influence and support of their families, these students also displayed a fierce determination to succeed in engineering, despite the difficulty some of them were experiencing academically. This determination extended to being able to contribute towards the development of their country in future, upon graduation. This in turn appeared to lead to an enhanced sense of self-worth, particularly as these students recognized that they were engaged in studying a BAS which was seen as prestigious by Emirati society. As previously mentioned, these students saw their personal identity as aligned with that of engineer, but beyond this they also recognized that they were safeguarding their future both financially and

as part of their wider society, as the rewards of graduating with an engineering degree were significant in this context.

5.3 Limitations to study

As this research study was carried out as a case study, the results of the study are not generalizable, as previously mentioned. Furthermore, only forty students responded to the online questionnaire out of the 152 students who were invited to take part and only three engineering staff took part in interviews. Nevertheless, while a larger sample size may have contributed more information to the study overall, the data which was collected and analyzed from these research participants proved to offer an appropriate amount of information to sufficiently answer the research questions posed. In addition, based on this data, it seems improbable that any new data would have emerged from further interviews. In addition, the decision to use a MMR approach and to triangulate the data by collecting it from a range of sources, ensured that this data was both rich in content while also proving to be trustworthy and reliable.

As this research was only carried out with engineering students at *the institution*, it does not provide the perception of engineering from students in other programmes at *the institution*. This research is also potentially limited in that the students who took part may be trailblazers in their field, more confident in taking part in research in general, and therefore not a reliable representation of either engineering students or students from any other division at *the institution*.

5.4 Recommendations for practice

The purpose of this research study was to identify the reasons for a group of students' decision to study engineering at one particular institution in Dubai. Although this was a case study and therefore not generalizable, based on the data collected it would appear that this is a trend which is likely to continue for the foreseeable future at *the institution*. Therefore, below are some recommendations for policy:

5.4.1 Institutional policy.

Based on the findings in this research, it is my recommendation that *the institution* investigates the possibility of introducing a broader range of engineering majors to the female students at *the institution*, similar to those already being offered to male students at the male campus of the same institution. As Emiratisation is one of the key visions of the UAE government, offering further STEM-related study options, particularly in engineering, could further contribute towards the potential number of graduates required to fulfill this initiative.

As *the institution* is part of a wider network of campuses spread across the UAE, it may be worth carrying out similar case studies at some of the other female campuses to identify if the same situation is likely to happen at those campuses in other emirates too. As the leadership of *the institution* implement a 'top-down' style of management, with 'vertical power' (Bess & Dee, 2008) cascading down through the organization, improvements and changes to the overall institution can take place rapidly as there is an expectation that middle management stewards *the institution*'s overall vision (Smith, 2001). Therefore, if STEM-related majors, particularly engineering, were increased at this campus there is the possibility that they could also be increased at other female campuses too. Certainly, as the academic culture of *the institution* is largely *developmental* (Bergquist & Pawlak, 2008), reviewing the number of engineering majors offered to female students aligns with its culture of striving to provide the highest educational standard for its students. As a federally-funded institution this is also important as the mission of this institution is to equip Emiratis with skills and knowledge to meet the future needs of the UAE, with a focus on UAE industry and society.

In fact, offering a wider range of engineering majors at this campus could even increase the institution's *social capital* within the community (Krishna & Shrader, 1999), in turn improving the number of students enrolling in this campus, if future students and their families develop an increased trust in *the institution* through a more equal set of educational opportunities offered to female students. This could potentially even support student retention (Sarker, Davis, & Tiropanis, 2010) as future students are given the option of studying

the type of engineering they can engage with most, ensuring students are more likely to persist in their engineering studies at this institution to graduation.

Where possible, I would also advise *the institution* to incorporate policies related to engagement with Emirati families, to advise them on the engineering programmes offered at *the institution* and the employment opportunities available to their female relatives as a result of graduating in engineering from *the institution*. This would not only benefit *the institution* through potential new student recruitment, but would also provide an increased number of Emirati engineering graduates to the Dubai workforce in the long-term. Based on this research, given the fact that the decision to study engineering appears to have occurred in these students' final years of High School, it is my recommendation that these institutional policies should provide information to Emirati families at this stage of their study path to have the greatest impact on encouraging more Emirati women into this field.

5.4.2 National policy.

It would appear from these research findings that the earlier that STEM-related subjects are introduced into the secondary school curriculum, the greater the chance that Emirati females will feel prepared and ready to study STEM-related subjects in HE. This is crucial if the government hopes to ensure a knowledge-based economy by 2021 and beyond. Therefore, based on this research I would suggest that the UAE's senior leadership should continue to promote STEM-related subjects throughout schools, including all-female schools. To further support the successful transition of High School students to HE, it would also be invaluable to align the current High School curriculum related to STEM-subjects with the first year engineering curriculum at *the institution*.

5.5 Recommendations for future research

Although there has been a recent rise in the number of students at *the institution* choosing to study engineering, it would be worthwhile to carry out a longitudinal research study to examine whether the majority of these students continue their engineering undergraduate studies or become "non-persisters" (Matusovich et al, 2010, p 289) and discontinue their engineering studies and to examine the reasons for this. This is particularly

relevant as to-date no research has been carried out to uncover why students choose and then persist with their engineering degree to graduation (Matusovich et al, 2010) in general, and certainly not within Dubai or the UAE. While Seymour and Hewitt's large-scale study showed that some reasons for students to not complete their engineering degrees included "the influence of family members, high school teachers,…materialistic reasons" or because they performed well in math and science at secondary school (1997, p 290, cited in Matusovich et al, 2010), this has not yet been explored at *the institution* or within this region. This longitudinal study could be carried out at *the institution* with Year 1 engineering students from two different year intakes. Data could be collected from these two student cohorts at different intervals as they progress through their undergraduate studies, to examine whether they persist and graduate in engineering or change their major to another BAS after initially starting in engineering and the possible reasons for this.

Current graduation rates at *the institution* for engineering students over the last few years have started to decline, according to Staff #1, who speculated that this could be attributed to the recent rise in the coursework requirements to graduate from engineering compared to students in other majors. Based on this I can speculate that although the number of students at *the institution* opting to study engineering has risen in recent years, the rate of persistence and subsequent graduation is still unknown for this particular cohort of students. Therefore, it would certainly be worthwhile to follow these students through their academic years at *the institution* to ascertain if the rise in the number of students opting to study engineering also leads to a considerable increase in engineering graduates.

In addition, although this research has shown that Emirati society has expanded to include women in the field of engineering as acceptable, Emirati females who choose to study this BAS at this institution have to complete a far greater number of credits to graduate from engineering compared to other majors at this campus. Indeed, besides the additional credits required to graduate from engineering, students' coursework has also "doubled, tripled, quadrupled in some courses" (Staff #1, line 38) within the last year of this research study, resulting in engineering students doing considerably more than other majors. Therefore, even

though Emirati females are accepted as having a role within engineering in Dubai, choosing to study this major at *the institution* requires a significant amount of perseverance to persist and to graduate. As a result, future research could also take this into account.

In addition to exploring persistent rates among engineering students at *the institution*, it would also be worth exploring the continuation of female empowerment in the UAE and how it influences and affects other fields within the country and society. This could be carried out through a documentary comparison of current and future government policies, along with semi-structured interviews of women at various levels of the UAE's social strata, including students in HE institutions and women in the workforce, as well as women in positions of leadership and even female policy-makers.

5.6 Summary

This chapter has discussed the findings of this research study in the context of Dubai and the UAE and offered some responses to the research questions initially posed. It would appear from the research that although these students are at the core of their decision to study engineering, their families, high school, and society also hold considerable influence on this decision (Figure 9). While the students themselves have their own beliefs, they echo both their families' and society's too. Although many of the students admit to finding engineering a challenge, they are largely content with their choice to study this major and have a strong self-efficacy in their ability to succeed in their studies through perseverance, which may also be linked to Dubai's belief that anything is possible, as promoted by the UAE government and Dubai's ruler. It is also highly likely that these students are motivated to succeed in becoming engineers, despite obstacles to this, so that they are able to contribute towards the development of their emirate and country in future through employment in this prestigious profession, as perceived and promoted by their society.

Chapter 6: Conclusion

6.0 Concluding remarks

The purpose of this research study was to understand the reasons for the rise in the number of female Emirati students at a HE institution in Dubai who had chosen to study engineering. This initially appeared to be in contrast with the cultural norms of Emirati society as the literature available at the time of this research study pointed to the fact that engineering was still seen as a male-dominated field to study and work in and Emirati females were traditionally discouraged or forbidden from engaging in these types of male-dominated fields.

As this research unfolded it became clear that there were almost certainly a multiplicity of factors surrounding these students' decision to study engineering. Therefore, this research aimed to capture the most significant influences on these students' decision to choose engineering, taking into account the intersectionality between structural variables and these students' personal traits, as shown in Figure 9, and the realization that the answers to the questions posed in this research were complex in nature.

When I first embarked on this research study I had a set of assumptions related to the reasons for these Emirati females to be studying engineering. Besides these assumptions, I discovered that there was a dearth of literature related to Emirati female students in general, but in particular a dearth of literature related to the reasons for these students to choose STEM-related subjects for tertiary level study when I first engaged with this topic. This led to a belief that uncovering the reasons for this particular group of Emirati female students to have chosen to study engineering required interviews with these students themselves.

By referring to research studies related to women's participation in STEM-subjects, in particular engineering, in other countries outside the Middle East, I was able to begin to understand the reasons or lack thereof for women's decisions to study engineering in other parts of the world. Therefore, while this research was enabled by the previous research of others outside the UAE, it contributed to this particular research in the context of Dubai. Indeed, this extended literature enabled me to create a questionnaire for these students, which

contributed to my initial understanding of their profile and individual situations and subsequently acted as a starting point for my interviews with these students. Having collected a rich set of data using an explanatory sequential MMR approach comprising of an online questionnaire and semi-structured interviews with some of the students, and having triangulated this data through semi-structured interviews with engineering staff and documentary analysis, I found that some of my initial assumptions were rebuffed due to the complex nature of the answers which emerged.

At the outset, this research study aimed to contribute towards the current literature related to Emirati women, towards their HE choices, and to uncover some reasons for their potential choice of STEM-related subjects such as engineering. As an insider researcher working directly within the context of *the institution* I believed that any data collected throughout this research study had the potential to provide a rich set of knowledge to broaden the literature in this field in this particular context, as opposed to research conducted by an external researcher unfamiliar with this environment. Indeed, as a result of the data collected throughout this research I believe I can confirm the fact that Emirati families continue to have a consistent and considerable influence on their female relatives as part of a larger collectivist society, as referenced in some of the existing literature. However, it would also appear that the astonishing rate of growth which the UAE has experienced has also contributed to a slight shift in Emirati society within Dubai, which has also had an influence on this society's decisions related to their female relatives' opportunity to contribute to their country.

The main idea which emerged from the findings of this research study related to a shift in Dubai society towards the increasing acceptance of Emirati women's place in the field of engineering. As this field was predominantly male, jobs related to engineering were previously considered to be only suitable for Emirati men, so Emirati society either discouraged or forbade Emirati women from taking a role in this field as it would have involved interacting with males outside their immediate family. However, although engineering in Dubai and the UAE is still considered to be male-dominated, there appears to have been a shift in society's acceptance of

Emirati women's involvement in this field, even though the necessity to interact with males outside their families still exists.

As Emirati families adapt to keep pace with the modernization and change happening in their country, it became clear from this research that they are mindful of the need to move with this change. Although the collectivist nature of this society remains intact, it also appears that Emirati families in Dubai have strived to support the UAE government in its future vision for the country. This has resulted in a slight shift in society towards gender equality and the inclusion of women in areas of the workforce which may have previously been considered culturally inappropriate, such as the male-dominated field of engineering. It has also resulted not just in this field being considered appropriate for Emirati females to work in, but also for families of these students to heavily support and encourage their female relatives to study and work in engineering. This research study found that one reason for this encouragement relates to the recognition that there are more job opportunities available in engineering in the UAE in general, but particularly in the much-coveted public sector which these female students strive to gain employment in.

Although these students have been given opportunities by the society they were born into and live in, so too they have an influence on the same society. Indeed, while they have a strong awareness of the constraints which this society can place on them, they are equally aware, consciously or unconsciously, of the benefits which they gain from being part of this society too. However, it would appear in this particular context that the freedom which these students now have has been optimized through the support of their government. Therefore, although a tension could have existed between these students desire to pursue their personal ambitions and Emirati society's cultural restrictions on Emirati females, this tension appears to have been partially eased as these students' current ambitions appear to align with the government's future vision for the country, thereby receiving the government's support in this regard. While these students are pursuing their own personal projects as primary agents working within the parameters of their family, national culture and traditional expectations, by aspiring to contribute towards the development of their country they are also working towards

being part of this larger collectivist structure. Conversely, although these students are not actively organizing change for others as corporate agents, they could still be considered indirect agents of change as their actions of choosing to study and eventually work in engineering have the potential to influence their natal society, thereby paving the way for other Emirati female students to choose similar paths in future. Although this is outside the scope of this research study, it would certainly be worth exploring further in future research studies.

As female HE graduates now outnumber males and the UAE moves towards a knowledge-based economy and the creation of more positions in STEM-related jobs, and as Emirati families encourage their female relatives to take up positions in engineering, they are further aligning themselves with the government's Vision 2021. This is also an important finding as it highlights a willingness for the indigenous community to engage in all sectors of the labour market, which also aligns with the government's initiative of Emiratisation aiming to provide jobs for all Emiratis of both genders.

Another aspect which this research has highlighted is that Emirati families are also likely to be encouraging their female relatives into the field of engineering due to their awareness that graduating with this BAS has a certain prestige attached to it not only in the UAE, but also in the wider region. When these Emirati female students graduate with this perceived-to-be prestigious qualification it not only portrays them as prestigious, but also reflects this same prestige upon their immediate and extended family.

I suggested earlier that the description of the UAE as either a developing or rentier country was something which was worth considering in this research study. However, now that I have carried out empirical research and have analyzed the data collected throughout this research, I do not believe that this has played any significant role in the findings of this research study. Regardless of the formal label which different official bodies such as the United Nations place on the UAE as a country, the position of its government remains unchanged with regard to their stance on supporting Emirati female empowerment. Indeed, Burden-Leahy believes that these labels are a "mischaracterisation" of the nation (2009, p 526) given that the UAE has its own set of characteristics which deem it to be unique in many regards, particularly in

relation to the extraordinary level of development which has taken place in this country in less than fifty years. However, regardless of the fact that some official bodies may have labelled the UAE as a rentier state, it is important to note that the time has passed whereby the bulk of Emirati graduates can be employed in the public sector. Therefore, regardless of the country's label, it is clear that the government has adopted a strong position to encourage all Emiratis into STEM-related HE majors so that they can contribute towards the development of the country and its economy.

Reflecting on the findings of this study as an insider-researcher at *the institution*, I recognize that this research has broadened my awareness of some of the influences on these students, providing me with a more informed insight into how Emirati females make choices related to their study and career paths. Indeed, the new knowledge which has emerged from this research will contribute not only to improving my own career counselling of future students at *the institution*, but equally place me in a stronger position to provide detailed advice to other stakeholders who provide similar support to students within *the institution*.

Although this research is not generalizable as it was undertaken as a case study, I believe it has the potential to provide a good springboard for further research in this area. Moving forward with this newly-discovered knowledge it would be worthwhile to research the retention rates of these students as they progress through the engineering programme at this institution, particularly given the difficulty of this programme at this particular institution compared to other majors and the fact that some of these students shared their experiences of struggling with engineering academically. As Student #8 shared her aspiration for more Emirati females to be given the chance to show how they can contribute to the engineering community, it would also be worth exploring the opportunities to engage with Emirati families prior to their female relatives making their program choices at *the institution*, to share information related to STEM-related majors, particularly engineering, and the myriad opportunities available to their female relatives upon graduating with this qualification.

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Appendices

Appendix A: University of Liverpool EdD VPREC ethics approval

Dear Caroline Jenns,		
I am pleased to inform you that the EdD. Virtual Programme Research Ethics Committee (VPREC) has approved your application for ethical approval for your study. Details and conditions of the approval can be found below.		
Sub-Committee:	EdD. Virtual Programme Research Ethics Committee (VPREC)	
Review type:	Expedited	
PI:		
School:	Lifelong Learning	
Title:	Improving women's access to STEM subjects in Higher Education: lessons from Dubai.	
First Reviewer:	Dr. Jose Reis Jorge	
Second Reviewer:	Dr. Greg Hickman	
Other members of the committee	Dr. Lucilla Crosta, Dr. Marco Ferreira, Dr. Anne Qualter, Dr. Dimitrios Vlachopoulos, Dr. Mariya Yukhymenko	
Date of Approval:	20/10/2018	
The application was APPROVED subject to the following conditions:		
Conditions		
1	Mandatory	M: All serious adverse events must be reported to the VPREC within 24 hours of their occurrence, via the EdD Thesis Primary Supervisor.
This approval applies for the duration of the research. If it is proposed to extend the duration of the study as specified in the application form, the Sub-Committee should be notified. If it is proposed to make an amendment to the research, you should notify the Sub-Committee by following the Notice of Amendment procedure outlined at http://www.liv.ac.uk/media/livacuk/researchethics/notice%20of%20amendment.doc Where your research includes elements that are not conducted in the UK, approval to proceed is further conditional upon a thorough risk assessment of the site and local permission to carry out the research, including, where such a body exists, local research ethics committee approval. No documentation of local permission is required (a) if the researcher will simply be asking organizations to distribute research invitations on the researcher's behalf, or (b) if the researcher is using only public means to identify/contact participants. When medical, educational, or business records are analysed or used to identify potential research participants, the site needs to explicitly approve access to data for research purposes (even if the researcher normally has access to that data to perform his or her job).		
Please note that the approval to proceed depends also on research proposal approval.		

Kind regards,
Lucilla Crosta
Chair, EdD. VPREC

Appendix B

UNIVERSITY OF LIVERPOOL

Committee on Research Ethics

INFORMATION SHEET FOR STAFF

You are being invited to participate in a research study. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask me if you would like more information or if there is anything that you do not understand. Please also feel free to discuss this with your friends and relatives if you like. I would like you to know that you do not have to accept this invitation and should only agree to take part if you want to. Thank you for reading this.

What is the purpose of this research?
To find out the reasons for the recent rise in the number of students at *the institution* choosing to study Engineering.

Why are you being asked to take part?
Your position and experience at *the institution* enables you to have a good insight into possible reasons for the recent rise in students choosing to study Engineering.

What are you being asked to do?
Choose to take part in an individual interview, which could last 15-30 minutes.

What will happen with this information?
All information which students share will be kept confidential and stored in the researcher's safe. All the information provided will be pass word protected and kept locked in a cabinet that can be accessed only by the researcher. It will not be possible to identify you in any publications of this research.

Do I have to take part in this research?
Taking part in this research is voluntary. You can withdraw at any time throughout the research, without any negative consequences.

What if I am unhappy with this research or there is a problem?
If you are unhappy with this research or if there is a problem, please let me know by contacting me (Caroline Jenns) on 050 6637443 and I will try to help. If you are still unhappy or have a complaint which you cannot share with me then you should contact the Chair of the Liverpool Online Research Ethics Committee at liverpoolethics@liverpool-online.com. When contacting this person please give details of the name of this research study (so that it can be identified), the researcher involved, and the details of the complaint you wish to make.

Contact details of the researcher

Name:	Caroline Jenns
Work address:	*The institution*, Dubai, UAE
Work telephone:	+9712 2061369
Work email:	caroline.jenns@*the institution*

Contact details of the Research Participant Advocate at the University of Liverpool

Work telephone:	+1-612-312-1210 (USA number)
Work email:	liverpoolethics@ohecampus.com

Appendix C

UNIVERSITY OF LIVERPOOL

Committee on Research Ethics

PARTICIPANT CONSENT FORM

Title of Research: Reasons for the recent rise in the number of students at *the institution* opting to study BAS Engineering

Researcher(s): Caroline Jenns

	Please tick (✓) box
1. I confirm that I have read and have understood the information sheet dated 6th May 2018 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my rights being affected. In addition, should I not wish to answer any particular question or questions, I am free to decline.	☐
3. I understand that confidentiality and anonymity will be maintained and it will not be possible to identify me in any publications. Additionally, I understand that no results of the research will be made publically available without my specific approval and that all information will be kept in the researcher's safe. All the information provided will be pass word protected and kept locked in a cabinet that can be accessed only by the researcher.	☐
4. I agree to take part in the above study.	☐

Participant Name	Date	Signature
Caroline Jenns	19.10.18	
Researcher	Date	Signature

Contact details of the researcher

Name: Caroline Jenns
Work address: *The institution*, Dubai, UAE
Work telephone: +9712 2061369
Work email: caroline.jenns@*the institution*

UNIVERSITY OF LIVERPOOL

Committee on Research Ethics

PARTICIPANT CONSENT FORM

عنوان البحث: الأسباب التي أدت مؤخراً إلى ازدياد أعداد الطالبات بكلية دبي للطالبات اللائي يفضلن دراسة الهندسة على غيرها من التخصصات.

اسم الباحثة: كارولاين جينس

1.أود التأكيد بأنني قد قرأت و فهمت ورقة المعلومات التي أعدت بتاريخ 6 مايو 2018 الخاصة

☐

بالدراسة أعلاه. و أنني قد اتيحت لي فرصة التفكير في المعلومات و توجيه الأسئلة و تمت الإجابة عليها بصورة مرضية.

2. أنا أفهم تماماً بأن مشاركتي في هذا البحث أختياري و لي حق الانسحاب في أي وقت دون إبداء أي

☐

أسباب و دون أي تأثير على حقوقي. أضف إلى ذلك أنني إذا كانت لدي الرغبة في عدم الإجابة على سؤال فلي حق الرفض.

3. أنا أفهم بأنه في خلال هذا البحث ستتم المحافظة على السرية و المجهولية أي عدم ذكر اسمي و أنه

☐

يستحيل أن يذكر اسمي في أي من المنشورات أو المطبوعات.

أضف إلى ذلك، إنني مدركة تماماً أنه سوف لن تكون نتائج البحث متاحة لأي أحد دون موافقتي الشخصية و أن كل المعلومات سوف تكون تحت الحفظ و الصون بواسطة الباحثة.

كل المعلومات المُتَحَصَّل عليها سوف تكون محميَّة بكلمة المرور (باسويرد) و سوف تُحفَظ في خزانة لا يمكن لأحد كشف ما بداخلها إلا عن طريق الباحثة.

4. أوافق على المشاركة في البحث اعلاه

اسم الشخص المشارك في البحث	التاريخ	التوقيع
كارولاين جينز	2018/ 5/ 6	

اسم الباحثة	التاريخ	التوقيع

تفاصيل الاتصال بالباحثة:

الأسم : كارولاين جينز
عنوان العمل: كلية دي للطالبات، ص.ب 16062، دبي، الإمارات العربية المتحدة
هاتف العمل : 97122061369
البريد الالكتروني: caroline.jenns@ *the institution*

Appendix D

Committee on Research Ethics

INFORMATION SHEET FOR STUDENTS

You are being invited to participate in a research study. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask me if you would like more information or if there is anything that you do not understand. Please also feel free to discuss this with your friends and relatives if you like. I would like you to know that you do not have to accept this invitation and should only agree to take part if you want to.

Thank you for reading this.

What is the purpose of this research?

To find out the reasons for the recent rise in the number of students at *the institution* choosing to study Engineering.

Why are you being asked to take part?

You are studying in Year 1 or Year 2 Engineering at *the institution*.

What are you being asked to do?

- Complete an online questionnaire of 20 questions, which could take about 10-15 minutes.
- Choose to take part in an individual interview, which could take about 15-30 minutes.

What will happen with this information?

All information which students share will be kept confidential and stored in the researcher's safe, so there will be no risk to you. All the information provided will be password protected and kept locked in a cabinet that can be accessed only by the researcher. It will not be possible to identify students in any publications of this research.

Do I have to take part in this research?

Taking part in this research is voluntary. Answering any questions is also voluntary. You do not have to answer any questions if you do not want to. You can withdraw at any time throughout the research, without any negative consequences.

What if I am unhappy with this research or there is a problem?

If you are unhappy with this research or if there is a problem, please let me know by contacting me (Caroline Jenns) on 050 6637443 and I will try to help. If you are still unhappy or have a complaint which you cannot share with me then you should contact the Chair of the Liverpool Online Research Ethics Committee at liverpoolethics@liverpool-online.com. When contacting this person please give details of the name of this research study (so that it can be identified), the researcher involved, and the details of the complaint you wish to make.

Contact details of the researcher

Name:	Caroline Jenns
Work address:	*the institution*, PO xxxx, Dubai, UAE
Work telephone:	+9712 2061369
Work email:	caroline.jenns@*the institution*

Contact details of the Research Participant Advocate at the University of Liverpool

Work telephone:	+1-612-312-1210 (USA number)
Work email:	liverpoolethics@ohecampus.com

UNIVERSITY OF LIVERPOOL

Committee on Research Ethics

INFORMATION SHEET FOR STUDENTS

لقد تمت دعوتك للمشاركة في بحث دراسي. قبل أن تقررين المشاركة في البحث، إنه من الضروري أن تفهمي السبب من وراء هذا البحث و ما هي الأشياء التي سوف ينضمنها البحث. الرجاء خذي بعضاً من الوقت لقراءة المعلومات التالية بعناية فائقة و لك الحق في أن تسالينى أي سؤال في حالة احتجتي إلى معلومات إضافية أو إذا كان هناك شيئ صعب عليك فهمه. أرجو أيضاً أن تناقشي هذا مع أصدقائك أو أي من أقاربك متى ما شئت. و أود هنا أن تعلمي بأنك غير ملزمة بقبول هذه الدعوة و عليك فقط القبول بالمشاركة إذا أردت ذلك.

لكم منا الشكر أجزله لقراءة هذا النص.

ما هو الهدف من هذا البحث؟

الهدف هو معرفة الأسباب الحقيقية للأرتفاع الذي حدث مؤخراً في أعداد طالبات كلية دبي اللائي يخترن دراسة الهندسة.

لماذا طُلِب منك المشاركة في هذا البحث؟

لأنك تدرسين في السنة الأولى أو الثانية في كلية الهندسة بكلية دبي للطالبات.

ما المطلوب منك؟

أكمل/ أكملي هذا الاستبيان الألكتروني (أونلاين) المكون من 20 سؤالاً و الذي قد يستغرف حوالي 10 – 15 دقيقة.
اختار/ اختاري المشاركة في مقابلة فردية و التي قد تستغرق حوالي 15 – 30 دقيقة.

ماذا سيحدث لهذه المعلومات؟

كل المعلومات الخاصة بالطلبة و الطالبات سوف تكون سرية للغاية و ستقوم الباحثة بحفظها في مكان آمن – فهي تحت الحفظ و الصون و لذلك سوف لن يشكل الإدلاء بأي معلومة خطراً عليكم.
كل المعلومات المُتَحَصَّل عليها سوف تكون محميَّة بكلمة المرور (باسويرد) و سوف تُحفَظ في خزانة لا يمكن لأحد كشف ما بداخلها إلا عن طريق الباحثة.
سوف لن يكون من الممكن تحديد أو معرفة شخصية الطالبات في أي من منشورات البحث.

هل يمكنني المشاركة في هذا البحث؟

المشاركة في هذا البحث إختياري. و كذلك الإجابة على الأسئلة فهي اختيارية أيضاً. و ليس هناك أي حرج إذا لم تجاوبي على كل الأسئلة، فيمكنك ترك الإجابة على الأسئلة التي لا ترغبين في الإجابة عليها. يمكنك الانسحاب من البحث في أي وقت خلال مدة سريان البحث و ذلك دون أن يترتب على ذلك آثاراً سلبية

ماذا سيحدث إذا لم أكن سعيدة بهذا البحث أو في حالة ظهور أي مشكلة؟

إذا لم تكوني سعيدة بهذا البحث أو إذا كانت هنالك مشكلة، الرجاء الاتصال بي (كارولاين جينز) على رقم الهاتف 0506637443 و سوف أحاول تقديم المساعدة المطلوبة. و إذا كنت ما تزالين غير سعيدة أو لديك شكوى لا تردين مشاركتي فيها عندها عليك الاتصال برئيس لجنة ليفربول للبحوث و علم الأخلاق التي تجرى على الإنترنت على البريد الألكتروني التالي:عند الاتصال بهذا الشخص، الرجاء إعطاء تفاصيل اسم هذا البحث (حتى يتم التعرف عليه) إضافة إلى الباحث و تفاصيل الشكوى التي تودين تقديمها.

تفاصيل الاتصال بالباحثة:

اسم الباحثة: كارولاين جينز
عنوان العمل: كلية دبي للطالبات، ص.ب. 16062 ، دبي ، الإمارات العربية المتحدة
هاتف العمل: 97122061369
البريد الالكتروني caroline.jenns@*theinstitutionf*

تفاصيل الاتصال الخاص بمسؤول المشاركة في البحوث بجامعة ليفربول

رقم الهاتف (العمل): 16123121210 (رقم الولايات المتحدة)
البريد الألكتروني liverpoolethics@ohecampus.com

Appendix E: Manual analysis of qualitative interviews

Theme	Student Interviews															Total*
	1	2	5	8	11	12	13	17	20	21	23	25	29	32	37	
Family's influence – aspiration for student to study engineering	1			1					3		1	1		2	1	**10**
Family support	2		2	1	2	2	2	1		2	1	1	1	1	1	**19**
Male engineering role models in family	1		1	2	1	1	1	1			2	1	3	2		**16**
Female engineering role models in family		2	1			1	1	1	2			1				**9**
Support from UAE labour market to employ females															1	**1**
To secure future employment	3		2	1	2		3		3	2	3	2	1			**22**
Good salary			1				1					1				**3**
Female engineering role models outside of family	1		2	1		1	1	1			1	1	1	1	1	**12**
Male engineering role models outside of family						1	1									**2**
Sense of achievement (upon graduation)				1	2	1	1			2	1			2		**10**
School teachers' encouragement		1							1							**2**
Desire to make a difference				1												**1**
Support from UAE government to study science	2														1	**3**
Contribute to their country	1			2	1	1					1	2	1		1	**10**
Financial independence					3								1	1		**5**
Prestige attached to engineering	1		1	1	1			1					1	1		**7**
Desire to work in private sector											1					**1**
Desire to work in government sector		1		1	1	1	1	1		1			1	1		**9**
Desire to work in semi-government sector									1							**1**
Desire to be unique/special	2				1	1						2	1		1	**8**
Desire to work on projects								1				1				**2**
Likes to work with their hands/practical								1								**1**
Visited a university exhibition (Najah)/fair									1						1	**2**
Interested in Math		1			1		1	1		1	1				1	**7**
Interested in Physics										1	1					**2**
Self-efficacy – good at Math	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**15**
Self-efficacy – good at Physics		1	1	1					1	1						**5**
Engineering is their passion												1	1	3		**5**
Chose engineering because lots of other girls are choosing engineering		1														**1**
Chose major (engineering) perceived to be the hardest					2				1				2			**5**

Influence of High School – majors designed to encourage students into STEM careers			1		1	2					1				**5**

*number of instances mentioned in interview

Appendix F: Interview protocol – version 3

Area of investigation	Interview questions
Welcome	Thank you for agreeing to this interview. I really appreciate it.
Engineering - a phase or a commitment?	Was engineering your first programme choice? How do you feel about studying Engineering now that you are in the programme? Why do you like engineering?
Influence of school and teachers Self-efficacy	*What was your experience of studying when you were at school?* *How did you feel about your teachers?* *How did you feel about your math and physics classes?* Were competitions ever held at your school to promote Math, Science or Engineering subjects? Did anyone ever come to your school to talk to you about Math, Science or Engineering studies or careers? (Were they women or men? Were they Emirati?)
Self-concept Self-efficacy	Is engineering a difficult programme? How do you handle the difficulty of engineering?
Early life and family influences Role models (familial or external)	Do you know any Emirati women who are engineers now or did you when you were younger? Who in your family is studying and working in engineering?
Military service / patriotism / working towards development of their country	Of your family who work in engineering, where do they work? Government or private sector? *Has anyone in your family done military service?*
Explore the influence of collectivist society (Hofstede)	*Who decides what you will study at college? (You? Someone in your family?)* Did your family advise you in your decision to study engineering?
Explore the influence of social media	What do you usually look at on social media? Do you follow any famous Emirati men or women? If so, who? Do you follow engineering? Do you follow women engineers?
Influence of UAE society on students' choice of engineering	How do you see a woman engineering compared with a man engineer? Are the roles different or similar? *Do you think engineering is a good job for Emirati women? Why/why not?*
Vocational interests? (Hubner et al)	Do you think it will be easy to get a job as an engineer when you graduate? Why/why not?

	Do you think there are more men or more women working in engineering in the UAE? Do you think there are more men or more women working in engineering in other places in the world? Why is that? Why would you prefer to work in the government/private sector?
Self-awareness	*If you hadn't chosen engineering, which Bachelors would you have liked to study?* When you think of yourself as an engineer, how do you visualize yourself?
Open questions – potential further exploration	What do you think motivated you to study Engineering? Why do <u>you</u> think that more and more DBW students are choosing to study Engineering? Is there anything you would like to tell me about engineering or why you chose it?

Interview protocol – version 7

Area of investigation	Interview questions
Welcome	Thank you for agreeing to this interview. I really appreciate it.
Engineering - a phase or a commitment?	Was engineering your first programme choice? How do you feel about studying Engineering now that you are in the programme? Why do you like engineering?
Self-concept Self-efficacy	Is engineering a difficult programme? *How do you handle the difficulty of engineering?*
Talent v hard work	Can anyone study engineering? Do you need special talent (or can hard work help you to succeed?)
Influence of school and teachers Self-efficacy	*What was your experience of studying when you were at school?* *How did you feel about your teachers? About your math and physics classes?* Were competitions ever held at your school to promote Math, Science or Engineering subjects? Did anyone ever come to your school to talk to you about Math, Science or Engineering studies or careers? (Were they women or men? Were they Emirati?)
Military service / patriotism / working towards development of their country	Of your family who work/study in engineering, where do they work? Government or private sector? Do you think it will be easier to find a job in the government sector as an engineer? *Has anyone in your family done military service?*
Explore the influence of collectivist society (Hofstede)	*Who decides what you will study at college? (You? Someone in your family?)* What was your family's reaction when you decided to study Engineering? Did your family advise you to study engineering?
Influence of UAE society on students' choice of engineering	Do you think there are more men or more women working in engineering in the UAE? How do you see a woman engineer compared with a man engineer? Are the roles different or similar? Do you think engineering is a good job for Emirati women? Why/why not?
Vocational interests? (Hubner et al)	As an Emirati female, do you think it will be easy for you to get a job as an engineer when you graduate? Why/why not? Do you think there will be more jobs available to you as an engineer than any other profession/any other major? Why would you prefer to work in the government/private sector? Are you planning on getting a sponsorship while you're studying?
Explore the influence of social media	*What do you usually look at on social media?* Do you follow any famous Emirati men or women? If so, who? Do you follow engineering? Do you follow women engineers?

Early life and family influences Role models (familial or external)	Do you know any Emirati women who are engineers now or did you when you were younger? Who in your family is studying/working in engineering?
Self-awareness	*If you hadn't chosen engineering, which Bachelors would you have liked to study?* When you think of yourself as an engineer, how do you visualize yourself?
Open questions – potential further exploration	*What do you think motivated you to study Engineering?* Why do <u>you</u> think that more and more DBW students are choosing to study Engineering? Is there anything else you would like to tell me about engineering or why you chose it?

Appendix G


التخصصات الأعلى طلباً في سوق العمل والأسرع توظيفاً
Majors Highest in Demand by Labor Market and Fastest to employ
مستوى الطلب
Demand
مرتفع جداً
Very High
مرتفع
High
متوسط
Average
منخفض
Low
منخفض جداً
Very Low
الهندسة
Engineering
التربية
Education
إدارة الأعمال
Business Admin
العلوم الطبية
Medical Sciences
تقنية المعلومات
Information Technology
العلوم البيئية والصحية
Environmental & Health Sciences
الآداب والعلوم الانسانية
Arts & Humanities
سرعة التوظيف
Speed of Employment
بطيء جداً
Very Slow
بطيء
Slow
متوسط
Average
سريع
Fast
سريع جداً
Very Fast
التربية
Education
إدارة الأعمال
Business Admin
تقنية المعلومات
Information Technology
الهندسة
Engineering
العلوم البيئية والصحية
Environmental & Health Sciences
الآداب والعلوم الانسانية
Arts & Humanities
العلوم الطبية
Medical Sciences

Appendix H: Responses to the open-ended questions 21 & 23 of online questionnaire

Student #	Question 21 How would you describe engineers? Are they different than any other profession?	Question 23 Why do you think that more and more students at your college are choosing to study engineering?
1*	Engineers should have important skills which are analytical thinking, time management, determining priority.etc. almost yes, because it needs hard workers, and to work under pressure in multiple tasks at the same time.	1- because other majors are full enough. (No More Jobs) 2- Some student think that being an engineer is something really high class without thinking how much effort it does need.
2*	yes	to have a good future
3	interesting, yes	because of a future job
4		New major for women students
7	yes because they have Intelligence and skill.	
8*	think that they are capable of solving things but no they can't. so much difference they study different stuff daily and all we do is physics	for the job opportunities available and the high salary rate
9	I think yes they are different. engineers are so smart	I think its because of the future jobs, but I have noticed that many engineering students changed their major because it was hard for them, even I thought about it but then I changed my mind because there is no other major i'm interested in.
11*	They are scientists	More jobs need engineering and female engineers are becoming better than men and the wage is extraordinary
13*	I have no idea	Because this what the country needs more. Engineers
14		It's the future
15	I think I love engineering only because it include Mathematics, because of that engineering have a special way in work.	1- Because they think it is not hard. 2- Because they only want to graduate as a engineers. Some students does not have the ability to intrduce engineering, student thought that enough to pass the subject. 3- Because other colleges or universities have a strong rules to join engineering but our college help them to introduce this major by teaching them all basics.

16	It's not that hard there are just few subjects that need focus and study for it to understand it and do well if there were any exam	In my opinion I see that other major not that useful because many people graduated after they take the other major and still didn't find any good job because the other major because before many people studied and graduated and worked that why they can't find a job
17*	they like to use there hand	for future jobs
18	1) it is something need from the persontobe verey focused and concentration 2) I don't have any idea	I don't know
20*	Ambitious.	
21*	Engineers are different from other professions. I can describe engineers that they are such a hard workers & successful people. Also, they are doing their best to achieve their goals.	They are choosing Engineering because it plays an important role in today's life & future. Nowadays, they need more local engineers. Also, we have many fields in Engineering.
22	Work hard	The main reason is the job
23*	We have creativity	For work or their skills
25*	actually it's a mixture of physics, math & art , it's really an enjoyable major.	honestly I think they choose it for being called eng :/
26		good future
27	Engineering is a quite difficult, its not like other professions. Engineers risk their life in terms of work	Its either to have a better jobs in the future or to be future engineers
28	great thing but needs effort	engineering has a future more than other major, also the engineer can work in several fields.
30	I do not see the qualities of a person when I say that this engineer studied in college so every person dreams and has a special goal on the bridge to reach him what matters is what he wants to study, for example I wanted to examine medicine and I love medicine a lot but sometimes circumstances make us change what we want and there are several reasons, but the most important It is a fun, creative, and experienced worker, if you don't like what you're studying will fail and tend to interfere badly. It is important to know	I don't know!

	what you want and not what you want your family or friends to have similarities in that we all get a living, but the difference in the areas of work.	
32*		Because it has a. Bright future and more job opportunities and high salary.
34	More with technology development	It's Helpful for the future
35	They have this ability think reasonably about problems and solutions, and find the smartest way to work out things	Because engineering jobs are highly damanded, and because of the salary. Also with the new technologies and new technology related courses in schools.
36	I think they're incridibles, yeah i guess they're different	For show, cause they want to show people that they can do something different but most of them can't handle it
37*	Every profession is different and has its good qualities and bad qualities. As engineers, we are able to apply our studies in our profession especially in math, science and business. Especially Industrial Engineering is different profession than any other profession cause it has different combinations interlated with each other.	The biggest percentages think its easy and we can handle it and its the only option that is available in our college since other profession has lots of students and the core problem the country don't want students in business or any other profession cause it loaded in our country.
38	-	Because it has a better future
39	Engineering is a challenge between your self to see that if you are able to manage your time with other objects	Maybe they are thinking it's good for there future, also because other majors like business everyone can study it.
40		I think it's either because that's what their parents what them to do OR they're not sure of exactly what they want to do, so they chose engineering just so their future can be 'secured' and 'safe' OR they wanted to be an engineer when they were growing up.

* Students denoted by an asterisk also took part in a subsequent interview

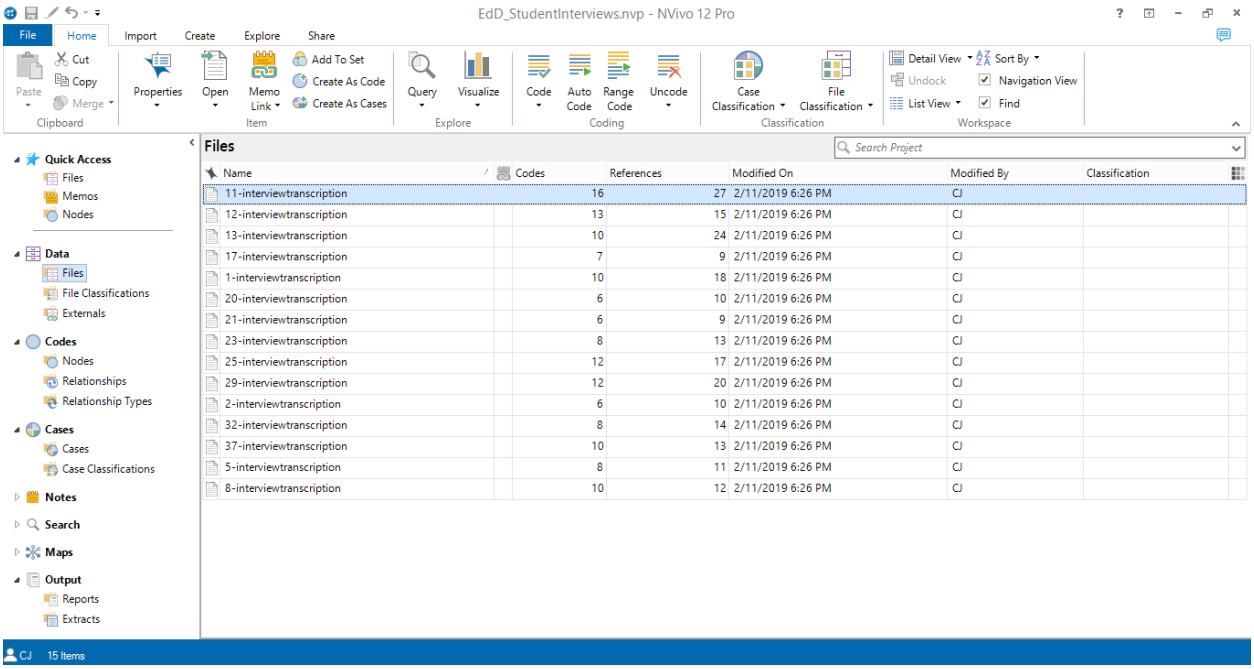
Appendix I: Responses to question #12 of online questionnaire

Student #	Why did you choose Engineering at college? (choose all that apply)
1	to function my abilities to serve my country* ;Future jobs;Looked interesting;I am good at Math and Science-related subjects;
2	Future jobs;
3	Looked interesting;
4	Future jobs;Looked interesting;
5	Future jobs;
6	Future jobs;
7	Looked interesting;
8	Future jobs;Looked interesting;I am good at Math and Science-related subjects;
9	Teachers at school;Future jobs;I am good at Math and Science-related subjects;
10	Honestly I've no idea.*;
11	Future jobs;Looked interesting;I am good at Math and Science-related subjects;
12	Future jobs;Looked interesting;
13	Future jobs;
14	Future jobs;Looked interesting;I am good at Math and Science-related subjects;
15	Family;I am good at Math and Science-related subjects;
16	Because it's something new* ;
17	Future jobs;I am good at Math and Science-related subjects;
18	Family;Future jobs;Looked interesting;
19	Future jobs;Looked interesting;I am good at Math and Science-related subjects;
20	Family;Future jobs;I am good at Math and Science-related subjects;
21	Future jobs;Looked interesting;I am good at Math and Science-related subjects;
22	Family;Future jobs;I am good at Math and Science-related subjects;
23	I am good at Math and Science-related subjects;
24	Family;

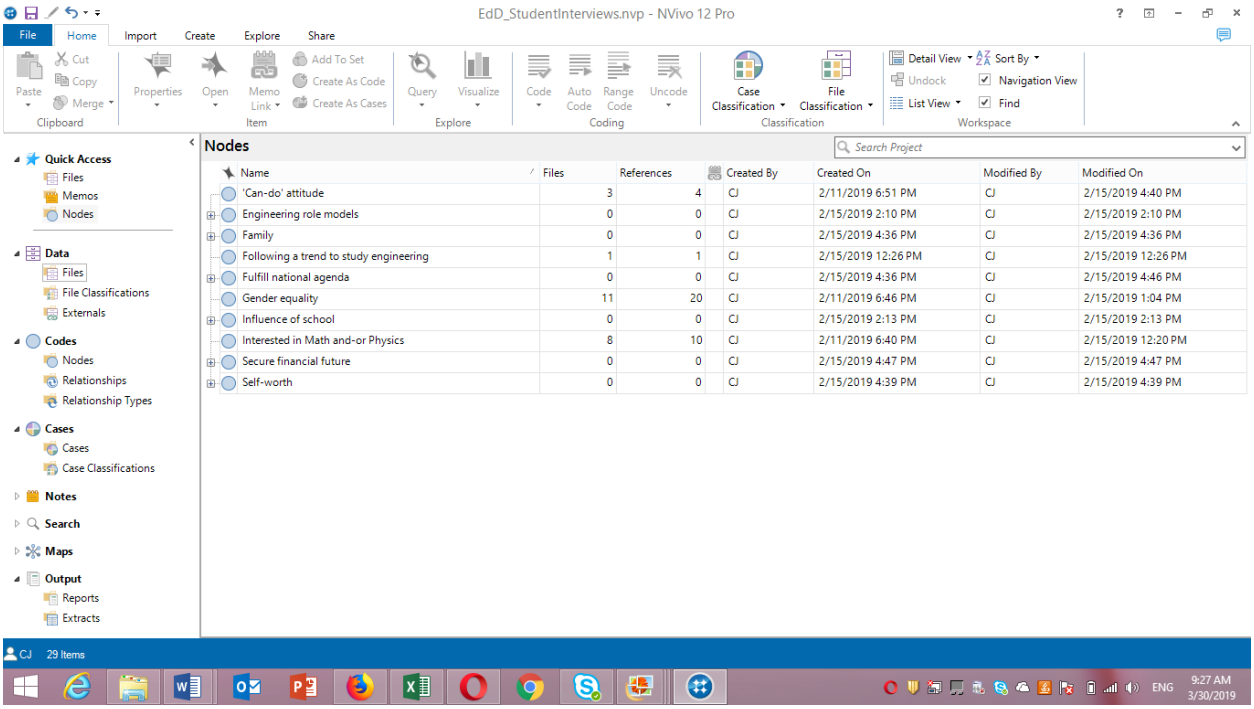
25	I am good at Math and Science-related subjects;
26	Future jobs;Looked interesting;
27	Family;
28	Family;Future jobs;
29	I am good at Math and Science-related subjects;
30	New things make me intrested.*;Future jobs;Looked interesting;
31	Future jobs;I am good at Math and Science-related subjects;
32	Family;Future jobs;I am good at Math and Science-related subjects;
33	Looked interesting;I am good at Math and Science-related subjects;
34	I am good at Math and Science-related subjects;
35	Family;Future jobs;Looked interesting;I am good at Math and Science-related subjects;
36	I am good at Math and Science-related subjects;
37	Wanted to study something different since my family is in law forces*;Future jobs;Looked interesting;I am good at Math and Science-related subjects;
38	Future jobs;Looked interesting;
39	To be unique* ;Future jobs;Looked interesting;
40	Enjoyed math related subjects;Family;Looked interesting;

* Student answers denoted by an asterisk were in the students' own words as a response to the option of 'Other'

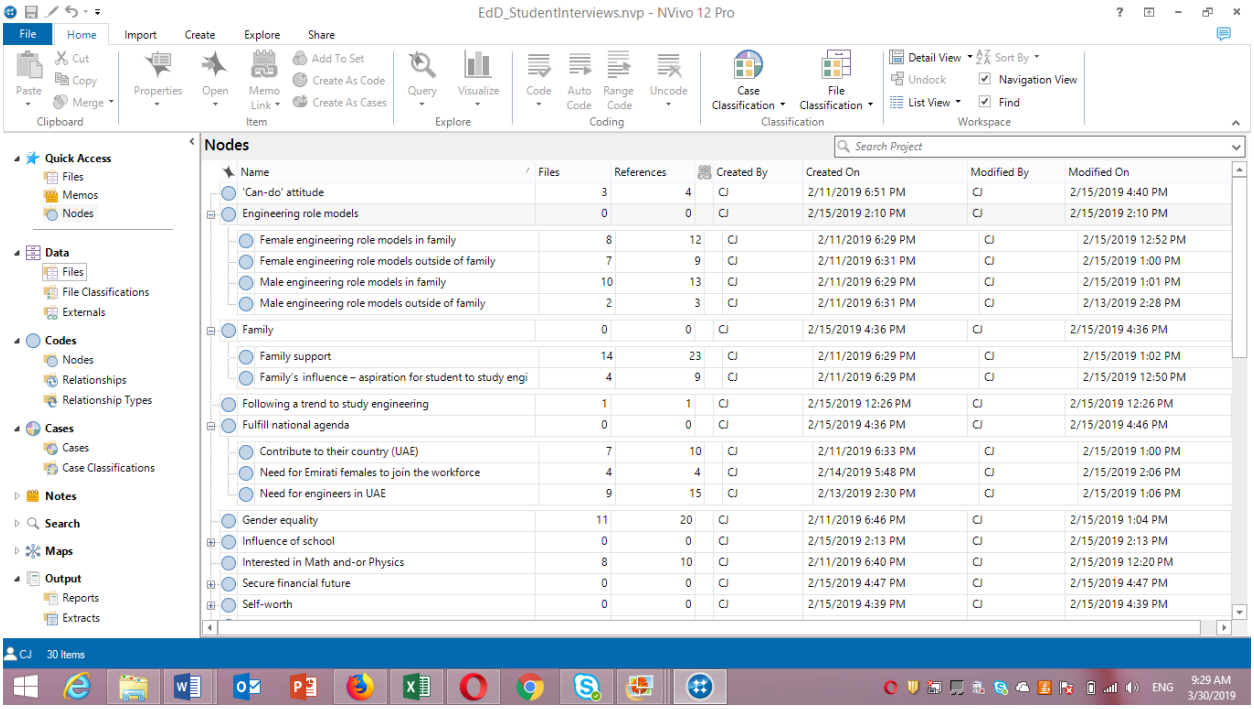
Appendix J: NVivo – interview transcriptions



Appendix K: NVivo – initial parent nodes



Appendix L: NVivo – child nodes



Appendix M: NVivo – parent nodes ordered by significance to this research